THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 57 Thursday, October 28, 1937 No. 1106

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1937-38

C. W. Bigg, "Selworthy," Burley Lane, Quarndon, near Derby.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham, 3.
East Midlands: B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.
Lancashire: J. E. Cooke, 7, Warren Drive, Swinton, Manchester.
London: R. Causebrooke, Thos. W. Ward, Limited, Thames Road, Silvertown, London, E.16.
Middlesbrough: G. P. Kirk, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.
Newcastle-upon-Tyne: C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Sheffield: T. R. Walker, M.A., "The Priory," Oughtibridge, near Sheffield.
Wales and Monmouth: J. J. McClelland, 12, Clifton Place, Newport, Mon.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
South Africa: F. C. Williams, Magor House (Fifth Floor), 74, Fox Street, Johannesburg.

Bristol: A. Hares, Park Crescent, 648, Stapleton Road, Bristol, 5.
Burnley: W. Haworth, 37, Westbourne Avenue, Burnley, Lancs.
East Anglian: J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.
Falkirk: H. McNair, "Braewick," Larbert Road, Bonnybridge, Scotland.
Lincoln: E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President: Sir Harold Hartley, F.R.S., Euston Station, London, W.C.1.
Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary: Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President: A. C. Turner, Russell House, Adelphi, London, W.C.2.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary: J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Colmore 4274-4275. Telegrams: CIRA
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE
Two Stalwarts of Science	331
Sheffield University Foundry Degree Course	331
Correspondence	332
Random Shots	332
Plant and Production Methods of Triplex Foundry, Limited, Tipton	333
Vocational and Technical Training of the Foundryman	334
Book Reviews	336
New Steelworks at Jarrow	336
Operation of a 24-inch Cupola	337
East Midland Foundrymen's Opening Meeting	340
Effects of Corrosion on Cast-Iron and Steel Piping	341
Segregation Phenomena in Lead Bronzes	343
Benefits of Scientific Control	344
Foundry Machine Production in the U.S.S.R.	344
Specifications	345
Ladle Safety Covers	346
The Week's News in Brief	348
Trade Talk	348
Personal	348
Contracts Open	348
Catalogue Received	348
New Companies	348
Forthcoming Events	348
Raw Material Markets	350

Two Stalwarts of Science

The country has lost two outstanding men in Sir John Dewrance and Lord Rutherford of Nelson, men of widely differing types and spheres of interest, yet having in common one profound conviction which guided many of their activities. That was a belief in science and in an industry based essentially on science. Sir John Dewrance was a link, through his father, with the early days of railway engineering in this country. He was concerned with both non-ferrous and ferrous casting, and acted for a period as President of the B.C.I.R.A. For an industrialist, and for the period of his most active work, his interest in science was unusual. It was a personal interest and one he freely assisted financially. He was a keen supporter of the National Physical Laboratory, and largely responsible for the work carried out as the Alloys of Iron Research.

The death of Lord Rutherford came as a greater shock because he was younger and still active as the responsible head of the famous Cavendish Laboratory at Cambridge, which recently received such a munificent gift from Lord Austin. Rutherford was an Empire figure, for he was born in New Zealand and had a period as professor in Canada before coming to Manchester and ultimately to Cambridge. But in reputation he was international. He placed British physics at the head of the world at a time when unparalleled developments were taking place in it. His genial personality might have been taken for that of a successful farmer. Not for him the abstruse mathematical developments which place modern physics in some aspects beyond even the ordinary scientist, nor the metaphysical speculation of others. He was first, last and all the time an experimentalist. Yet in later years he gave up much time that he could ill spare to become chairman of the Advisory Council to the Department of Scientific and Industrial Research, and to spread in many speeches the importance of the scientific point of view. He was deservedly honoured by burial in Westminster Abbey last Monday, and the country mourns two distinguished men, one almost the creator of modern physics, and the other one who saw that if science had to be applied it had in the first place to be created.

Sheffield University Foundry Degree Course

Considerable progress is being made in the foundry section of the Metallurgical Department of Sheffield University. To the layman it would appear that the progress registered was not very striking, but it must be remembered that, during the first two years at the University, there is no intense specialisation. The student is receiving tuition in chemistry, physics, mathematics and general metallurgy. The time has now arrived for students to decide whether, during the last two years of their training, they will qualify for a foundry practice degree, and it is pleasing to report that of the metallurgical day students eight honours' undergraduates are taking the full-time course. This represents a majority. Prof. Andrew is definitely of opinion that the new departure provides a better general training for any metallurgist, whether he is desirous of taking up foundry practice or not. In order to do justice to the foundry course a new laboratory is being erected and will be completed before the end of the year. Moreover, the equipment is constantly being augmented.

This course of study, which has been developed by the Institute of British Foundrymen, is the only one of its kind in the British Empire. It places foundry metallurgy on a plane commensurate with civil, mechanical, mining and electrical engineering, and represents the highest order of training available for men destined to be the future executives of the industry. From 1939 onwards there is every reason to hope that reliance can be placed on the Metallurgical Department of Sheffield University to provide the foundry industry with a continuous supply of young men possessing a training well qualifying them to be of real assistance to overworked foundry managers and foremen, by relieving them of many aspects of technical control.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cleaning Castings by Hydrofluoric Acid

To the Editor of The Foundry Trade Journal.

Sir,—In response to the inquiry in your issue of October 21, we would advise you that the following method is in commercial use:—

The operation is carried out in a rubber-lined tank in which commercial hydrofluoric acid is diluted with an equal weight of water to produce an acid containing 30 per cent. HF. Castings from which sand is to be removed are immersed in the diluted acid for periods varying from 15 min. to 3 hrs. The time of immersion is partly governed by the amount of sand to be removed, but a more important factor is that, during use, the effective strength of the bath diminishes as the result of the reaction between the hydrofluoric acid and sand.

Hydrofluoric acid baths of this type are usually kept under chemical control, and when the percentage of effective HF falls below 15 per cent. the bath is brought back to 30 per cent. by the addition of fresh hydrofluoric acid. This naturally entails running away a portion of the bath. After appropriate treatment the castings are washed in running water.

Given chemical control, the operation is simple and effective, but it should not be embarked upon without providing the workers with adequate protection. They should be provided with substantial and effective rubber gloves and should wear goggles. Hydrofluoric acid on the skin causes intensely painful burns, which may be quite dangerous in certain circumstances. Adequate forced ventilation should also be provided, since the vapours which are emitted have definite poisonous properties.—Yours, etc.,

J. R. Booer,
Chief Chemist,
F. W. Berk & Company, Limited.

52-54, Leadenhall Street,
London, E.C.3.
October 23, 1937.

Apprentice Moulder Training

To the Editor of The Foundry Trade Journal.

Sir,—I was very surprised and disappointed to read your reactionary leader on this subject in your issue of October 21, discounting all the good work which has and is being done by education authorities, the Institute of British Foundrymen, employers and those interested in the well-being of the foundry workers for the raising of their status and general level of education.

I agree that the boys entering the foundry from the elementary school at fourteen are in the majority definitely deficient in the three R's. This is an acknowledged fact not only in this trade but in all, and for this reason alone it has been found necessary to form the preliminary courses in our general scheme of technical education. Every boy leaving school at fourteen should automatically proceed to the evening classes, and it is in the employers' own interests to see that they do so, and for the employers to make it easy for them so to do, by paying fees, wages increases depending on progress or in some other tangible form.

True, certain boys have an aptitude for learning, but in my experience one cannot tell until they have tried, and I could mention some remarkable instances of apparent "duds" waking up in a surprising fashion after a few months at school. If you start with twenty boys at fourteen you will find that a good few fall by the wayside, and you will only have, say, one in twenty continuing to the end of the complete course of five or six years' study. In the foundry trade we find about one in thirty employed are foremen or charge hands, who should have some modicum of knowledge of the technical principles underlying their trade, and this figure agrees fairly well with the possible recruits for management personnel the employers are always complaining they are finding it so difficult to obtain.

The improvement in boys attending evening classes is very marked, and their progress in the foundry as judged by practical standards agrees very closely with their results at school. The practical work should be taught on the floor, and many foundries look after this by having several rows set apart for training their promising lads under the eye of the foreman, but even the simplest scientific principles underlying the practical work cannot be taught there, and how much easier it is to turn out good men when their brains are stimulated and active through their having been taught to think for themselves, and how much easier to train them.

Scouts, Rovers and Territorials are excellent organisations in their way, but if you will obtain the opinion of the leaders in these movements you will find they are all for their lads going to classes and are the first to recognise the benefits to the lads in later life. In these organisations you will find also that only a few really become good leaders, *i.e.*, those who have the inherent ability.

Good teachers are essential and naturally produce good results, but they are few and far between, and the only way to find them is to take them from those who have the practical experience obtained on the floor and have travelled the full distance in the educational courses. The more students, therefore, the better chance of an adequate supply of teachers. It all rests with the employers and parents to see that their boys go to school. The excellent courses arranged by the Institute of British Foundrymen in conjunction with the education authorities are there waiting for students

To say that incentives offered by employers do not lead to success is definitely contrary to experience. In the early years incentive and almost compulsion is definitely required, as the three R's seem dry and disagreeable stuff to learn, but if by learning these essentials the boy gains some tangible advantage he sticks it, and as he grows older he sees where it is all leading and how it helps in his work, and he becomes keen. Incentive is essential until it becomes customary for a boy to go to classes when he starts work.

If you will study the various courses laid out for draughtsmen, patternmakers, foundrymen, etc., you will find that when the knowledge required is common to one or more courses suitable provision is made, and there is no necessity to have any animosity, and I do not believe it exists to any extent. Before saying more it would be interesting to know who shows the animosity—the education authorities, the students or the employers. If draughtsmen, etc., want to take moulding courses, let them—how often in your columns have you lamented the suffering of the foundryman by the lack of moulding knowledge on the part of the draughtsman.

Everyone agrees that it is essential to have some interest outside one's daily work, but this does not mean that education should be neglected for it. In the early years of a boy's life his education is paramount, and the courses have plenty of general scientific and engineering knowledge applicable to everyday things, outside his own trade, to create interest. I wonder, Sir, whether you have ever seen the interest shown by a class of foundry lads when they first do a few simple experiments in the physics laboratory and noticed the first dawning of intelligence and the realisation of the relation between theory and practice.

Please do not decry the need and value of scientific training, however small in the foundry trade, which is the most backward of any except perhaps agriculture; otherwise, in spite of the excellent research work that has been done in recent years, we shall remain doing as our grandfathers have done, progress will be slowed down and the very object for which your journal is published—the dissemination of knowledge—defeated, and the Institute of British Foundrymen become defunct.

Yours, etc.,
B. E. Stott, A.M.C.T., A.M.I.E.E., M.I.B.F.
(Director and General Manager).
Ferrous Light Castings, Limited, Warrington.
October 22, 1937.

Sulphite Lees as Core Binder

Y. A. Tomin, writing in "Liteinoe Delo," No. 4, 1937, says that cores made with sulphite liquor as binding agent possess a number of disadvantages, chief of which is the adhesion of the core mixture to metal core boxes and the hygroscopicity of the dried cores. It has been found that a considerable improvement follows the treatment of the liquor with alkali, particularly NaOH. The addition of chrome-potash alums to the sulphite liquor also gave promising results.

Random Shots

"Brighter Branch meetings" seems to be the slogan these days in the Institute of British Foundrymen. Many members will remember with pleasure the informal supper which the London Branch staged three years ago at one historic London tavern. The East Midlands Branch later reciprocated this hospitality by providing a tripe supper, which was much appreciated by devotees of that particular brand of furnace lining, but probably gulped with eyes shut by a good many more. Not to be outdone in this commendable movement, the Birmingham Branch last week entertained London to a supper in which Clam Chowder was featured, together with chips served in the advertisement pages of The Foundry Trade Journal! A few over-civilised people resorted to the fork, but most of the members present preferred, and quite obviously enjoyed, the more primitive method of using the fingers. It was a delicious irony that caused one guest to be served with chips wrapped in the advertisement of a rival concern!

* * *

Talking of cheery innovations which help to colour this beige existence (drab is altogether too dull a term), two friends of "Marksman," who used to meet each other for supper once every week, decided to put on a series of suppers, taking it in turn to work through the alphabet. Everything was simple until the letter "K" was reached, and this taxed the ingenuity of the presiding host quite considerably. Nevertheless, his quick brain at last overcame this difficulty by producing a Welsh Rarebit, explaining to his puzzled guest that it was not a Welsh Rarebit so much as a Kambrian Koney!

* * *

A firm of publishers has recently been advertising for a woman graduate in chemistry to act as a temporary "devil." It must be noted that a printer's devil is of a special type, quite different from the species to be found in most business concerns. As the post is of a temporary character one wonders if the same firm will offer her the post of office cat, or will they just return her to her laboratory, there to continue the sort of sorcery for which she got her degree?

* * *

The answer to last week's traffic problem is, of course, that the lorry driver broke no rules because he happened to be walking home after his day's work.

* * *

The one-way traffic system in Birmingham, states a well-known corpulent consulting metallurgist of that city, is becoming so bad that it is now definitely impossible to be sent to Coventry.

* * *

The popularity of the Stamp Exhibition recently held in London has confirmed the growing suspicion that with a trade revival stamp collecting has come into its own once again. Neither is it a pastime confined to the schoolboy, but has a tremendous following amongst hard-headed business men. Has the ardent collector ever stopped to ask himself just why he finds his hobby so completely fascinating? Striving in one's business activities after perfection and cursing daily the errors of one's fellow-workers, is it not a joy to sit by the fireside with one's collection, and actually be able to reverence errors with a fervour almost amounting to worship? Or is it?

* * *

The latest objection to the new threepenny bit is that it is not suitable for putting in the Christmas pudding. That is Mother's point of view. Junior thinks otherwise, for this year they'll have to put in sixpences.

"Marksman."

Plant and Production Methods of Triplex Foundry, Limited, Tipton

The Triplex Foundry, Limited, manufacturers of Triplex grates for domestic heating and cooking, at Tipton, Staffs, were the hosts of The Institute of Vitreous Enamellers on the occasion of the 4th annual conference. The works occupy an area of approximately 13 acres. At the present time the number of employees engaged is about 700, and of these probably half are employed in the foundry proper. It will be seen from the description which follows that the works are laid out on very modern lines, departments being so arranged in relation to each other that flow is continuous and doubling back of work reduced to the lowest possible minimum.

It may be mentioned here that compositions vary somewhat for different castings according to the object they are to serve in the finished grate, and in the case of those which are porcelain enamelled, the analysis and quality of the metal are factors of great importance.

A View of One of the Moulding Bays at the Works of Triplex Foundry, Limited.

Entrance to the works is gained through a block housing offices, the showroom and related departments, behind which lies the foundry.

The Foundry

Coke, limestone, foundry pig, and scrap are delivered to the yard by lorry. Considerable stocks must be carried in order to maintain the output, which averages about 200 tons of castings per week. Immediately adjacent to the yard are the cupolas, seven in number. Only three are required in operation per day, and a system of rotation is therefore followed, those in use on one day being allowed to stand idle on the next. Blast is supplied to each cupola by a fan driven by a 50-h.p. motor. Pig, scrap and limestone are weighed out and mixed, elevated to the charging-platform by hoists and charged from either side of the cupolas, the hourly output of which is about 11 tons. The molten charge is tapped into ladles slung from an overhead runway. Along this they are drawn by hand down a central bay on the foundry floor for distribution to hand shanks which supply the moulds on either side. The moulds are prepared from pattern plates, of which an enormous variety is stocked, covering every type of grate produced by the firm. Special care is taken in facing the moulds, since the majority of the castings are of comparatively light section, and must finish with a smooth surface free from porosity, particularly in the case of faces which are subsequently vitreous enamelled.

Fettling and Machining

After knocking-out, the castings are transported by means of a runway to the fettling shop, where the flash is ground off and adhering sand removed by shot-blasting on a compressed-air operated conveyor type machine. On the output side of this plant they are inspected, weighed, and entered into store. From here they are withdrawn as required by the finishing or machining departments.

Operations carried out on the machining section comprise drilling, milling, grinding, edging, polishing and sizing. Oven doors, for example, are ground flat on the inner side to ensure a flush fit, while the lugs for the hinge-pins are milled to correct length between the outer faces and are afterwards drilled on a specially adapted horizontal driller to take the pins. Every operation is carried out on jigs, and each machine is so placed that a continuous forward movement of the work is maintained.

From this point the stream of work is divided, certain components passing directly on to the assembly section, and others being carried forward through the vitreous enamelling section back to assembly.

Preparing Components for Vitreous Enamelling

Two classes of material are dealt with in the enamelling section, namely, cast iron and sheet steel. Sheet is subjected to a preliminary ' burning off " followed by pickling in sulphuric acid to remove scale and to promote the adhesion of the enamel. Castings, on the other hand, undergo a different treatment. In order to stabilise them against change of shape during firing, they are first annealed in a Gibbons coal-fired muffle furnace. Articles are hung on Cronite supports for this treatment, great attention being paid to the manner of the hanging in order to minimise distortion. After annealing, the castings are run through a conveyor-type Wheelabrator shot-blasting plant.

This machine is provided with two throwerheads which deliver in all 600 to 700 lbs. of shot per minute on to the work as it passes below them on a heavy rubber belt to which it is transferred from the roller-conveyor system. The castings travel through at approximately 7½ ft. per minute, and on emerging through the rubber guard flaps on the output side, are either lifted by hand on to another conveyor running close by, or are turned over and run through the Wheelabrator a second time in order to prepare both sides for enamelling; they are then transferred to the second conveyor. Operatives handling this work are all provided with gloves, since contact with the bare hand results in poor adhesion of the enamel.

Enamel Spraying at the Works of Triplex Foundry, Limited.

Before entering the enamelling section for spraying, the conveyor bearing the shot-blasted components passes under a blower which removes

(*Continued on page* 339.)

Vocational and Technical Training of the Foundryman*

By H. BUNTING

In considering the foundry industry from the apprentice's or young foundryman's position, one must ask oneself what is required and what there is to offer the young man entering the foundry to-day. There is a great demand for skilled craftsmen and for men to take executive positions; yet, despite the demand, there is a large majority of men who would leave the industry if they could obtain a suitable job elsewhere. While that state of affairs exists, is it to be wondered that the industry does not get the type of boy entering the foundry so earnestly desired? The Institute has done very valuable work to improve the position both through the Branches and its various committees, and the fostering of the City and Guilds Examinations for foundry practice, all of which are helpful.

In considering the training for foundrymen, it is necessary to separate the vocational or workshop training from technical training. Some advocate that the various technical colleges and schools should install a foundry. With this the author does not agree, not insisting that a foundry is of no use in a college, but it has not the value some would suggest. It is very useful in a minor way for assisting those whose work is of the foundry, but not in it. In their case practical demonstration is of great assistance, and it can be useful in correcting many of the errors which are found in foundry practice, providing the teacher is a qualified man.

Faulty Tuition

Two glaring cases of faulty tuition have recently been experienced. Personally, during the conduct of an examination in foundry practice, it was noticed that all the candidates, in venting the mould, hit the pattern each time the vent wire was put in. On questioning the candidates at the end of the examination, it was revealed that they had so been taught. The other instance was in an examination of some of the ways candidates made the runner bush. The teacher concerned complained that he always had a quantity of dirty castings. A visit to his foundry revealed that practically all his bushes were made up in that manner.

The difficulties in workshop training to-day are due partly to the fact that most simple jobs on which the boy received his early experience are now put on the machine. Although, from the training of the moulder, one may deplore the loss of this valuable asset, one has to recognise that the change is due to the evolution of industrial conditions.

There are some who advocate the foreman having the boys together for several hours each week; this course is mostly advocated by those who are not foundry foremen. Personal experience is that he has enough to do without that duty. The best training method is to have the boys together, either in a part of the shop set apart for the purpose, or in a separate shop wherever possible and under the supervision of a practical man who is suited for the position.

Periodically, as the occasion arises, the youth should be transferred into the other section of the shop, not permanently, but for a period. Then he should be returned into the apprentice section; this has the effect of giving him an incentive to work so as to get out again on the larger work. Whenever possible, the lad should work with a different moulder each time. If this method was carried out in foundries wherever possible, in a decade the shortage of skilled moulders would be overcome.

* Paper delivered before the East Midlands Branch of the Institute of British Foundrymen.

It is often advocated that the youth should have part of his time in the patternshop and other departments; with this view the author is not entirely in agreement. For the youth who shows neither ability nor inclination for technical knowledge or leadership, but who may with proper training develop into a fairly efficient craftsman, his time would be far better spent in the fostering of his practical work. The training period is already far too short for learning his trade, without time being spent in other departments. With the youth who shows ability for technical training, then by all means give him the opportunity to prepare for greater responsibilities.

Technical Training

In considering the technical training of the youth entering the foundry, one has to consider the type of recruits obtained and not the sort one would like. Personal experience of the boy entering the foundry to-day is that the standard of education is no credit to the educational authorities of the country. Some may insist that the boy entering the foundry has the same amount of intelligence as the boy entering other sections of industry. Personal experience disproves that view; from the whole of the successful students who have passed through his hands, 70 per cent. are not what one would call foundry workers. No reference is made to 70 per cent. of those who have passed either the City and Guilds or the East Midland Engineering Union examinations, but who have gained either honours or first-class pass.

The syllabus should be framed as simply as possible, and yet be made interesting for the first year. The first year, apart from laying the foundations, can be regarded as training the individual to think, not by an intensive system of crammed knowledge, which is often only temporary, but to educate in such a manner that the knowledge gained will be retained. This may sound a very simple elementary project, yet it requires a fair amount of patience and tact. In a class there usually are two groups, one consisting of those who are slow in grasping the various points put forward, whilst the other section readily absorbs and retains the knowledge imparted. The point is to carry along one group without retarding or boring the other section, and likewise sufficiently to advance the other section without confusing the slower thinkers.

After the first year, the students continuing the course are usually those who are keen and capable of advancement. If the class be composed mainly of youths, and if there be facilities in the area for part-time attendance at the classes, then additional subjects can be taken. If only evenings are available, then do not overload with subjects.

Syllabus for Foundry Practice

1st Year.

Moulding sands. Various types of moulding sand. Strength. Influence of size and shape of grain. Moisture content. Sand testing, mixing and conditioning of sands. The use of coal dust, blacking and parting powder. Elementary aspects of moulding, (*a*) green sand, (*b*) dry sand.

Cores and core making. Methods of supporting cores in moulds.

The uses and principles of moulding machines.

Cupola. Construction and operation, blast pressure and volume, charging the cupola. Refractories used in cupola practice.

Mixing metals. The effect of carbon, silicon, sulphur, managanese and phosphorus on the physical properties of cast iron.

Shrinkage, contraction, warping, taper and camber in patterns. Materials used in the foundry. Mensuration as applicable to foundry practice.

2nd Year.

Physical and chemical properties of moulding sand. Mixing sands, sand mixing plants.

Moulding green sand and dry sand.

Core making. Sands used in core making. Core binders, washes and paints.

Cores made from boxes, strickled or swept up.

Pig-iron, its production and uses in the foundry. Composition and grading of pig-iron.

Cupola practice, methods of charging the cupola, control of cupola melting, melting losses, coke ratios, physical properties of coke. Fluxes, various types of melting furnaces. Composition of cast iron. The mechanical and physical properties of cast metals.

Weighting of mould and cores, pressure of metal on mould and cores, casting temperature. Designs which produce defective castings.

Fettling, grinding, sandblasting, pickling.

Moulding machines, various types, squeeze, jolt. Stripping plate and pattern drawing machines.

Calculations for foundry work.

3rd Year.

Loam moulding, designing and laying out and making tackle, construction of loam moulds.

Malleable cast iron, composition, whiteheart and blackheart processes.

Annealing. Testing of malleable cast iron.

Non-ferrous foundry practice. Metals and alloys in ordinary use. Brasses. Bronze. Aluminium alloys. Die-casting. Type of melting furnaces for non-ferrous metals.

Testing metals. Foundry layout. Construction and application of mechanical appliances used in foundry work. Stoves and portable dryers. Drying temperature. Air compressors, fans, blowers. Blast pressure and volume gauges.

Mixing metals to analysis. Special mixtures. Foundry management.

Syllabus

Evenings.

1ST YEAR.

Foundry Practice.
Practical Maths.
Machine Drawing.

2ND YEAR.

Foundry Practice.
Inorganic Chemistry.

3RD YEAR.

Foundry Practice.
Inorganic Chemistry.
Metallurgy.

No claim is made that this scheme is the only method for training or that it is the ideal that one looks to, but it is insisted that, based on many years' experience, both from the practical foundry side and from the control of technical classes in foundry subjects, it has proved successful, and that is the only measure—results. If the manipulative skill can be improved in conjunction with an improvement in the technical knowledge of the trade then the industry will materially gain.

In his closing remarks Mr. Bunting said that it was rather regrettable that a large number of foundry executives were composed not of men who had had practical experience in the foundry. It was often said that the foundryman was useless for those jobs, but he did not agree. Until recent years, he did not consider that the foundryman had the opportunity of gaining the knowledge that was necessary for the mastering of his trade, to be able successfully to undertake executive work, but he did not believe that

to be correct, because of the facilities that were now being brought forward all over the country, due in no small measure to the Institute. There would rapidly come a time when the man who had the practical training, providing he had abilities for executive positions, would be able materially to increase the numbers of those men keeping them.

DISCUSSION

Mr. W. T. Evans (Branch-President) said that Mr. Bunting's Paper brought very much before them the serious problem they had to face in education. They knew Mr. Bunting had been more successful than most people with his educational programme.

Mr. P. A. Russell said he himself had had a little experience in foundry classes, but could not claim anything like the success of Mr. Bunting. The class for which he had been responsible started with 35 students, and by the third year there were only ten. In his opinion classes were required for foundrymen of two types. Firstly, the ordinary boy, who merely wanted to increase his knowledge of the trade and get some useful help in his ordinary routine in the foundry, and there was the second class, who really wanted to qualify for foremanship. He thought everyone ought to have that chance. The syllabus, in his opinion, was too elaborate for the ordinary foundrymen, and they could not be expected to spend years to acquire such data. The educational authorities with whom he had made contact insisted that, before a boy went to a technical school, he must attend evening institutes for two years, unless he had attended a secondary school, and it was the practice that they went there for the ground work in mathematics and machine drawing, which was essential. He considered the student should have reasonable groundwork by that time, in foundry practice and machine drawing. Mr. Russell added he was merely pointing out some of the difficulties he had encountered, and did not want to appear to be criticising.

Commenting on Mr. Bunting's observation that the practical foundry in a school was not of much assistance in teaching apprentices, Mr. Russell agreed there was no place like the foundry for the trade to be learned, but some foundries were specialised, and a boy trained in such a foundry was useless to the general foundry industry. The boy must therefore get more than lectures from the foundry classes. No one foundry could attempt to cover all classes of work. He did not think one could cover all classes of work in school, but the boy's knowledge could be widened, and a boy should not be familiar only with his own class of work. For that reason he believed that a practical foundry and a practical evening course were very desirable. Things could be illustrated in a practical foundry that could not be illustrated on a lecture table. He thought Mr. Bunting's three-year course was an ideal course for the man who was prepared to go the whole way for executive position.

Mr. F. J. Cook (Past-President of the Institute) thought Mr. Bunting had been wise to divide his Paper. He agreed that one could not teach craftsmanship in a technical college, and the foundry they had visited earlier that day had gone a long way to show that. There they had a specialised way of moulding. The man who was trained in the ordinary way was useless in that foundry. There were not many who would doubt Mr. Bunting when he said that the practical training had to be done in the foundry itself. Unfortunately, there were so few foundries which laid themselves out to give the vocational training. A boy had to rely on his own resources as to what kind of work he got; the management generally took very little pains to teach him the trade. He thought there was a change coming in that connection.

Some foundries had set apart a section with a leader who was able to impart to the boys a knowledge of the craft. It was on the technical side that people disagreed. One had always to cater for a varied class of boy. There would have to be more form of segregation, and one would have to segregate the boys after the first year.

Educational Fundamentals

Mr. Walter suggested, as an educationalist, that the educational authorities would welcome any movement, however slight, to get a progressive work for the young men in the foundry. There were difficulties everywhere; he had previously experienced a fading-out of students by the end of the third year, and thought they ought to be persuaded to take an alternative subject. They were again starting classes which would probably overcome the difficulty by letting the course be of a more practical nature. If this was kept going by a "live" man, a man who was skilled in the practical moulding himself, it would cover some of the difficulties. He had wanted the students to take a special class in drawing, and designated it "Foundry drawing." Only four students presented themselves. He found the reason was that half of the people were already taking classes of the same nature. The urge for the classes had come from the firms themselves.

Mr. Walter added that education was supposed to be given to enable them to live a happier life, but did it? The pace of life was going so quickly that he did not think a boy leaving school was fully developed. He had tried, first of all, to persuade the very young boys of 14 to come to evening classes, and the reply was that it was not much use to them, as it was not their job. They did not require a great knowledge, did not like mathematics, and disliked most things, so he put on an industrial class which would be more applicable to their own work. The drawing they made of a descriptive type. the "English" was taught under the guise of "science," and the "mathematics" as "drawing." This, he said, would be a useful industrial course.

Mr. C. D. Pollard said that he, like Mr. Bunting, had experienced the difficulty of handling boys. The crux of the whole thing was to make the boys think. The teacher should have the ability to make the boys think, and the foundry manager should encourage boys to ask questions.

Mr. R. Buckland, who said he had been connected with the training of foundry apprentices, agreed with Mr. Russell that it was essential for the course of a college to include a practical course. From the point of view of enticing the student to the college, he felt sure that if they were only going to take mathematics and drawing, very few students would attend. The mere fact that there was practical work to be done enticed them to take the whole course. With regard to the number of subjects, and the allocation for the years, Mr. Bunting had only included drawing for the first year, as well as mathematics, but it was not included in the second and third years. He thought the average student in the foundry, if he attended the first year for drawing, did not pick up very much. As an alternative, it was suggested that a boy should be taught in the works by a foreman, but foundry foremen in these days had much to do. Mr. Bunting had mentioned that he did not agree with sending a boy to the foundry for three to four months from another department. To a certain extent he was probably right, but in one case Mr. Buckland knew, from putting a boy in the foundry one found he was more adapted to that work than his own department.

Examination Handicaps

Mr. Joynes, a past student of Mr. Bunting, referred to 30 per cent. of the foundry students who did not obtain first-class honours in an examination. In his opinion, it was the way in which the marks were allotted at examinations. He hardly thought it fair that half of the marks should be given to drawing, taking into consideration the draughtsmen and patternmakers who attended classes and who were conversant with the drawings, and the foundry student who very rarely saw a drawing. Probably if the foundry boy took a three-year course in drawing it would make him qualified to read a drawing, but actually to produce a drawing was asking a little too much at an examination. He did not consider that a foundry student should be put on the same lines as patternmakers and draughtsmen who were constantly using drawings in their daily work. He thought a sliding scale should be adopted at an examination; for example, the patternmaker be given a few more marks for knowing practical moulding and drop a few marks from the drawings of the draughtsmen.

Primary Education Deficient

Mr. W. H. Smith said in his opinion they were actually starting at the wrong end in trying to educate the foundry boy. He thought they ought first to educate the whole of humanity, next the employers, and then the students. Mr. Evans had remarked that if a firm were prepared to give facilities for their boy, they were no better thought of, and at the same time could not ask for better prices. That was the whole economic principle that was wrong.

Mr. Smith thought the major move had to come from employers. Nowadays a boy who went into a foundry had to get a job with generous pay; some of them obtained more money than a boy who attended classes. Boys had to be encouraged, and unless they got that from the place at which they worked, they would not get it elsewhere. Referring to Mr. Bunting's remarks "70 per cent. passes," who were non-foundry people, he wanted to know the figures of actual students who were working in foundries actually on the floor. Of the boys who could go from foundries to the Technical College, and carry through the three year course, how many passes would be secured? The draughtsmen and patternmakers who took up those classes, made the effort themselves, without encouragement. What successes was Mr. Bunting having with the boy they were trying to educate?

Loading the Dice

Mr. S. Horton, as a student of Mr. Bunting, thought there was much to be said for the introduction of a practical foundry course in the classes. They only had a practical course for the first year, and there was a larger attendance that year than ever they had for a technical subject. This gave the practical man a chance to shine. The majority of the patternmakers were top of the class in examinations. It would be a good inducement to the foundry boy if practical moulding were introduced, as it gave him a chance to compete with the draughtsmen and patternmakers.

Mr. Hallamore said he was very glad Mr. Smith had mentioned Mr. Bunting's 70 per cent. In training of the boys, he would like to know what method Mr. Bunting had. Was the idea to get those boys who were already in foundries, or to get boys who were leaving school and hoped to go in foundries? To his mind, the hardest jobs with the foundry boys was to keep them. It seemed a pity that the idea of foundry apprenticeship had gone.

Mr. H. Cochrane said a boy should have more practical experience, and more training in the handling of metal. The modern foundry to-day was relying on mechanisation, and little craftsmanship was needed. He failed to see, in the case of a mechanised foundry, where all the training was necessary, and the training ought to be left to foundries themselves. Regarding the chances a boy had of rising to an executive post, he thought there was very little chance for this. They would have to be trained to a higher education.

Author's Reply

Mr. Bunting said Mr. Russell had told them that in Leicester students had to attend the ordinary evening school before they were admitted to technical classes. Unfortunately, in Derby, they admitted them straight into the col-

lege, with very little knowledge of either mathematics or drawing. Regarding Mr. Russell's point on foundries in technical colleges, which he considered a great help to the youth coming from a different class of work, he did not know whether Mr. Russell had considered the time that was at the disposal of the students. Speaking as a practical man, in the first place, the assistance gained in the practical college, for the ordinary student, was not worth the time spent on it. To put students who were probably working on better work on something that was more simple, would not achieve anything. There were, however, certain points that were useful. The college foundry was useful from a demonstrative point of view.

Regarding Mr. Cook's point of training the boys separately, this was not new. When Mr. Bunting entered a foundry, they had a separate shop for the boys. The boys were drafted out as they made progress, or as they were required. Mr. Walter, he believed, had spoken mainly on the various types of students. This was one of the difficult problems they were faced with, and which required a certain amount of tact.

Mr. Buckland had mentioned not having sufficient mathematics and drawing training. Mr. Bunting said he did not care to overload the syllabus, but if a youth was keen, he would take those classes. He put down what he would call compulsory subjects. One of the secrets of holding the students together was by not overloading. In regard to his remarks on boys in other departments, Mr. Bunting had tried to emphasise that point a little, that to those who showed progress, and were capable of going in for higher positions, better works, etc., then he agreed with it, but not for it to be done by lads of 16 or 17 years of age, before they had common sense.

In reply to Mr. Joynes, who had said he did not agree with the way in which examination Papers were set out, and the way marks were allocated, he should realise that the examination was for bringing to notice those people who were capable of taking up executive positions, and they were assumed to have that knowledge necessary and essential for those positions.

Mr. Bunting said he would not, in the first place, agree with Mr. Smith. He had said that more should be done by the employer. From what Mr. Bunting knew of many firms, the employer was doing a great deal, and if the individual was not prepared to do something himself, he was not worth bothering with. Mr. Smith had said that no boy entered a foundry from his own inclination, but he was of the opinion there was plenty of scope, providing they were prepared to work.

Both Mr. Hallamore and Mr. Smith had misunderstood his remarks as to examination passes. He had said that "70 per cent. of those who had first-class passes were not of the foundry." Actually 84 per cent. of the students he prepared had passed examinations, including moulders, patternmakers, draughtsmen and others, the majority of them foundry lads. His point was that he regretted that 70 per cent. of those who gained first classes, or honours, were not from the moulding shop.

Vote of Thanks

Proposing a vote of thanks, Mr. Peace said that at various times they had talks about education of boys in the foundry, and he thought it was the first time he had ever been to a meeting where they had got down to the facts. No doubt Mr. Bunting felt amply rewarded by the discussion that had ensued, as it had been brought out by people from so many different aspects of the foundry trade. He felt the employers should do more than they generally did at present. Actually, in the foundries themselves, there were very few places where boys were given separate training.

(*Concluded in next column.*)

(*Concluded from previous column.*)

Mr. Spriggs, in seconding the vote of thanks, said Mr. Bunting had impressed him by the great amount of work he must have done for years in training people for the foundry, and his optimism proved that he was not pursuing a lost cause. He did not believe that no boy could rise to an executive position in a foundry. If that attitude was adopted, they would not get anywhere.

Mr. Bunting briefly acknowledged the vote of thanks.

Book Reviews

Magnesium and Its Alloys. By J. L. Haughton and W. E. Prytherch. Published by His Majesty's Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 2s. 6d.

Widespread use of magnesium alloys as structural materials is of comparatively recent date. It is, therefore, a matter of no great surprise that general information of industrial and technical value, whilst abundant, should be somewhat scattered and confined largely to proprietary alloys in the form of booklets issued by the manufacturers. This monograph presents in a very assimilable form a digest of such data already published, together with many results obtained during the course of the investigation of the metal and its alloys at the National Physical Laboratory, and hitherto unpublished; special prominence has been given to these results.

The book is divided into seven chapters, the first dealing with the metal, its sources, production and properties. The economic significance of the metal is at once revealed by a study of the data relating to the distribution and output of magnesium-bearing minerals. Possibly because it is still the chief method of obtaining metallic magnesium, the electrolytic extraction process is dealt with in some detail; mention, too, is made of the interesting process employing a molten lead cathode. In view of the manifest advantages to be derived from such processes, however, a little more information regarding methods involving the thermal reduction of magnesite would surely have proved of great interest; reference is made in a footnote to a source of further information, but this does not entirely compensate for the extreme brevity with which this important development is treated.

The notes on corrosion phenomena in magnesium alloys are excellent, particularly those in connection with attack by "doped fuels." The technical departments of aircraft and automobile manufacturing concerns would probably have welcomed a short mention of corrosion by lubricating oils and cooling fluids, especially by the former in the "used" condition, in which state it has been known to cause considerable trouble. While perfectly satisfactory methods are extant for mounting magnesium alloy components in intimate proximity to those of other metals in such a manner as to reduce the possibility of accelerated electrolytic corrosion to a minimum, difficulties in connection with the jointing of feed systems and gauges, etc., to fuel and oil tanks in these alloys are not always so readily solved; the tubes, unions and nuts employed must commonly be made of a more "noble" metal, and unless special precautions are taken, violent corrosion may occur. The omission of helpful suggestions in this regard is to be regretted.

Chapter II, on melting and casting practice, is treated thoroughly in the minimum of space, while for Chapter III, on plastic deformation, the authors deserve the highest commendation for their masterly handling of a mass of very complicated data, so much of which has hitherto been available only in German periodicals in a rather diffuse form. Chapter IV is of special interest, as it deals largely with the results of experiments on the rolling, forging, extrusion and heat-treatment of magnesium alloys carried out at the National Physical Laboratory; again, these results are here published for the first time.

The mechanical properties of the alloys at room and at elevated temperatures are dealt with in Chapters V and VI. The data presented here are of first-rate importance, and are excellently arranged in graphical and tabular form. An extremely wide range of alloys, proprietary and otherwise, is covered; attention should be directed, especially to the binary and more complex systems containing silver, and to those containing cerium; both silver and cerium give promise of playing an increasingly important part in the development of alloys showing good mechanical properties at elevated temperatures. Engineers and designers may find the thermal conductivity values of alloys given in Table 36, page 62, of great value, since such data are not at all easily come by.

Chapter VII treats in detail of the constitution of the alloys of magnesium; it includes a useful bibliography, the references being grouped under the heading of each system noted. Thirty-six binary and ternary diagrams are reproduced, the source and special features of each, or appropriate comments, being given in an analysis on pages 75 to 81. This is decidedly a volume which must be added to the technical executive's library.

Der Eisen und Stahlgüss (Gusseisen, Tempergüss, Hartgüss, Stahlgüss) auf dem VI Giesserei-Ausstellung (Düsseldorf, September, 1936). Iron and Steel Castings (cast, malleable and chilled iron; steel castings) at the 6th Foundry Technique Exhibition. By Prof. E. Piwowarsky. Published by Giesserei-Verlag G.m.b.H., 27, Ludwig Knickmann Strasse, Düsseldorf. Price 17.50 Rentenmarks.

Unless one happened to be in a position to spend several whole days at the Düsseldorf foundry exhibition, it was a physical impossibility to absorb and especially record all the information made available so graphically. Prof. Piwowarsky has done a real service to the foundry industry by collecting all the available data and assembling it into book form. There are 164 pages, containing 322 illustrations. These latter are particularly valuable, as they portray the exhibition in miniature. The book follows closely the lay-out of the exhibition and is divided into seven main headings: (1) The technical and social aspect of the foundry industry; (2) grey cast iron; (3) malleable; (4) chill cast iron and rolls; (5) steel castings; (6) co-operative exhibit of available literature; and (7) conclusions. Section 2 is obviously the most important, and is divided into 32 sub-sections, ranging from first-aid to welding. An excellently conceived and executed exhibition well merited the publishing of a descriptive book, and no better authority could be found than Prof. Piwowarsky.

V. C. F.

New Steelworks at Jarrow

The Commissioner for the Special Areas of England and Wales, Sir George Gillett, announces that he has now arranged to lease the land he is acquiring at Jarrow, Durham, to a new company which is being formed to build and operate a plant for the manufacture and rolling of steel. This is the company to whose proposed formation the President of the Board of Trade, Mr. Oliver Stanley, referred in the House of Commons on June 22. The Treasury has agreed to the Commissioner's recommendation for remission of National Defence Contribution, and also to provide loan money from the fund created under the Act. The Nuffield Trustees are taking a large number of shares. The balance of the total capital of £1,000,000 required for the proposed undertaking is being subscribed in part by the Consett Iron Company, Limited, and in part through the intermediary of the Bankers' Industrial Development Company.

Operation of a 24-inch Cupola*

By F. A. ANDREW

When preparing the cupola for a blow, all adhering slag must first be chipped from the lining. A layer of ganister or other refractory material is then applied on the walls where fluxing of the lining has taken place. Where there has been excessive wear, leaving depressions or cavities, these places should not be filled with ganister only, but with pieces of firebrick bedded in ganister, the walls being left fairly smooth so as not to offer any opportunity to the coke and iron charges of hanging, or alternatively of their damaging the lining. If the cupola be still warm after patching, this will help to bring about the best conditions of the repaired parts to enable them to withstand the subsequent heating during the next blow.

If the patching has been extensive and the cupola has become cool, it is advisable to light a slow fire; this and the draft helps to dry the ganister which, if of the correct quality, will only require a short period. If the ganister is of the type termed "fat," drying may take many hours, and may not be complete when the blow is commenced. This will mean that, when it is subjected to the intense heat prevailing during blowing, spalling is liable to occur, and this makes itself heard as sharp reports caused by the material being liberated by unequal expansion. This becomes mechanically mixed with the charge and interferes with correct fluxing and melting, causing low-temperature metal and slow melting. If extensive, the conditions in the furnace may become so bad as to necessitate stopping the blow for the day. The chipping on the following day will be prolonged, and the damage to the lining will necessitate more extensive patching.

The best patching material to use, therefore, will be one consisting of a high percentage of silica and just sufficient fireclay to help the material to adhere to the walls and to bond the silica grains together. Such a material is highly permeable, and on that account is quick-drying, so that if a consignment of ganister dries rapidly it indicates generally that it is more satisfactory than a slow-drying consignment. Excess of water in ganister is at all times undesirable, but least desirable with a "fat" and low-permeability ganister due to the tendency to crack and spall unless slowly and completely dry.

Putting in the Bottom

After repairing and drying the lining, the bottom is formed by ramming in sand to a depth of about 5 or 6 in., sloping to the tap hole. Just as much care is required as in the making of a mould, the sand being evenly and firmly rammed; the ramming should be very thorough near the walls to prevent the metal forcing a way between the sand and the walls. The sand used must be sufficiently strong to hold together without excessive moisture or ramming. Excessive water or ramming will cause boiling, and may result in scabbing or damage to the bottom, with possibly complete flotation of a portion of the bed of sand, resulting in a run-out by fusion of the plates. Very fine sand may have the same effect unless certain elaborate precautions are taken, so that it is advisable to avoid this material if possible. Some of the other causes of a run-out may be:—(1) Use of coarse, burnt sand; (2) excessive hammering at what is termed an "iron hole"; and (3) failure to secure the bottom plates sufficiently to avoid movement when carrying the burden charged into the cupola, resulting in development of cracks in the sand bottom through which the metal flows, aided by trickling away of burnt sand if such material has been used.

A run-out is, of course, a serious matter, and usually an attempt is made to remedy matters without dropping the bottom. In such a case, the first thing to do is to stop the blast and draw all possible metal from the tap holes until slag appears. If all draft has been excluded by closing the tuyeres, iron will soon cease to melt, and the flow of metal from the leak will also cease, to be followed by slag. Unless the damage to the sand bottom is extensive, the slag will soon congeal and make up the leak, this being hastened by the application of water from a hose. In some cases it is found possible to resume blowing after about ten minutes, and it may be possible to complete the blow due to the slag having closed the opening and thus, owing to its melting point being comparatively high, remaining unaffected by the molten iron above it.

It is sometimes customary to vent the sand bottom by laying wires horizontally on the plates, these being withdrawn after ramming has been completed and the holes left serving as an outlet for steam and being one method of preventing boiling.

Putting in the Front

If there is only one opening in the furnace to serve for tap hole and breast opening, a layer of ganister is laid on the centre from a point just within the furnace and continuing at the same slope as the sand bottom to the spout, and on this a bar, of about 1 in. diameter, for forming the tap hole, is laid. Cokes selected for their length are then built up to form a wall with a small bridge over the bar to facilitate easy withdrawal. The outer ends of these cokes come approximately level with the internal diameter of the cupola for reasons explained later.

The building of this wall requires a little skill, as it must remain in position when the necessary kindling material is added and after ignition of same. The kindling can now be added, consisting of, first, a good supply of shavings and then a liberal supply of dry firewood, this latter being preferably of pieces about a foot long in the case of a small cupola, to prevent the formation of a hollow place and subsequent collapse, with consequent risk of a poor fire. Where there is doubt about the dryness of the patching in places, a few long pieces are sometimes laid sloping against the walls at these places before adding the bulk of the wood, in order to protect such places from damage at the start. The shavings can now be ignited, and as soon as the wood commences to burn, coke is added. If the coke be too large, the fire will not burn up uniformly, and large gaps may be formed, leading to cold spots delaying commencement of the blow. If small coke and breeze be added, the draft will be impeded and again cause delay, also resulting in trouble due to small pieces of coke blocking the tap hole when the metal commences to melt.

Subject to the operations having been carried out correctly, the fire will have burned up in from a half to one hour, and when the coke has become red above the tuyeres, these can be closed and the front made up. Failure to allow the coke to burn up in this way will delay the production of hot molten iron, as it will be seen that if air be prevented from entering at the bottom, all air must come down the shaft or down from the tuyeres, and combustion is therefore slowed down. The reverse to this is when the fire burns up too quickly, as in frosty weather, and then it becomes necessary to close the front earlier to prevent the coke wall at the breast burning away and collapsing.

The fire having burned up, and having been poked from time to time to enable the coke to settle and occupy the space previously occupied by the kindling, a lump of ganister is built up over the bar for forming the tap hole, the inside of this ganister being level with the internal diameter of the cupola and as level as possible on its inner face. The outside of the breast opening is damped or claywashed, and the remainder of the opening around and above the ganister is filled with dampish sand; the front plate is put in position and secured, finishing by ramming between the plate and the shell at all points to resist any possible escape of metal. The tap hole can then be prepared by cutting away the ganister above the iron bar to form a tapered hole.

The sides of the spout are made up of sand or ganister and the bar withdrawn. By means of a bent wire, the length of the parallel hole left can be determined, and if necessary more ganister is cut away until the parallel hole is only about $\frac{3}{4}$ in. long. The inner face is then made fairly smooth, and of a shape to correspond with the conical "botts" or plugs of clay used for stopping the flow of metal.

In practice very little, if any, of the clay plug should enter the actual tap hole, being held in position by adherence of its conical sides to the sides of the tapered hole just outside the tap hole. It is customary in some places to form a depression in the tip of the clay plugs and complete the point with the aid of a good moulding sand. This sand, when "botting-up" takes place, partially enters the cylindrical tap hole and aids materially in tapping out and the prevention of an "iron hole" due to iron solidifying in the tap hole during a long wait or in the early stages of the blow before the tap hole has been properly warmed up.

Charging

After making up the furnace front, the bed coke will have become well heated up, and coke can be brought up to the correct height, about 18 to 24 in. above the top of the tuyeres, at the same time care being taken (by poking the tuyeres) that hollow places do not give a false height of the bed which would result in dull metal.

The charges of metal, coke, and limestone can then be added according to predetermined practice. Where very hot metal is not essential, it is often customary to put a double charge of metal for the first charge for reasons of coke economy and also to add the last charge of iron without coke. The latter is quite in order as, theoretically, due to the continual replenishment of the bed, there is sufficient coke at the finish to melt the last two charges of metal on one charge of coke.

Weight of Charges of Metal

There is a divergence of opinion as to the weight of charge for any particular diameter of furnace, but it is advisable to err on the low side rather than on the high side. On a 24 in. cupola the writer prefers to keep to a maximum of 300 lbs. in order to obtain uniformity of mixtures and avoid fluctuations in temperature. A typical series of charges giving high temperature metal sufficiently fluid to run castings $\frac{1}{4}$ in. thick would be:—

Coke	.....	45 lbs.
Limestone	.....	6 lbs.
Metal	50 per cent. Pig 50 per cent. Scrap	..... 300 lbs.

With much thicker castings, the proportions in the same furnace may run to 1 of coke to 10 of iron. In a larger furnace, good hot metal (sufficiently hot to run pipes, roof gutters, and other light castings) has been obtained by the writer with 91 lbs. of coke and 1,120 lbs. of iron.

Commencement of Blowing

The blast, at a pressure of 10 to 16 in. of water (6 to 9 ozs.) is next applied. If the height of the bed has been correct, metal will be seen from the tuyere holes in about 8 minutes and will have commenced to flow from the tap hole

* Paper read before the Junior Section of the Lancashire Branch of the Institute of British Foundrymen, Mr. A. Hopwood presiding.

in about 12 to 15 minutes. This time will vary with the height of the bed and will also depend on the extent to which the coke bed has become heated before the blast has been put on. While the first metal is flowing, poking at the tap hole should be avoided except in the case of stoppage due to a piece of coke, in which case a $\frac{3}{8}$ or $\frac{1}{4}$ in. wire should be used to clear the obstruction. The use of a larger rod or bar is liable to cause a stoppage of flow by rapid extraction of heat and consequent chilling of the metal.

The iron flowing from the tap hole should be allowed to make its own way, the only help given being to remove any metal that has solidified on the relatively cold spout and which in turn may at the commencement solidify following metal. When about 10 to 15 lbs. of metal have passed and if the hole is clear, it may be plugged for a short period of a minute or so. Then the plug is carefully removed from around the sides in such a manner that the centre is forced away by the flow of the metal. If the blast again appears at the tap hole and the metal is flowing hot, it can again be plugged and the metal may be allowed to collect for a tap for some unimportant job or this metal may be poured in an ingot mould.

Afterwards, given regular charging and supply of blast, and provided the tuyeres are kept clean, no further trouble should be experienced throughout the blow. Each tap, the preceding plug must be completely removed and in this way the tap hole kept clean. Slag should not be allowed to escape from the tap hole, and the furnaceman should anticipate this by judging the diminution of force behind the metal. At intervals it will be necessary to run off the slag, and during this process the metal will rise in the well of the furnace as the blast will be continued, except maybe for a short period during the opening of the slag hole and again when closing with sand after all the slag has been removed. This closing of the slag hole is necessary if great losses of heat are to be avoided, although on some furnaces in certain circumstances it is not practised.

If slag were allowed to rise continually with a closed slag hole, it would foul the tuyeres and probably stop the blow. Generally, the height of the slag hole is about 6 in. below the tuyeres, and where the breast and tap hole are at the same point a separate hole is provided in the casing for the purpose, a spout being also provided, and both spout and hole lined with ganister. When the tap hole is distinct from the breast plate, the slag hole and spout may be incorporated in breast or back-plate, as it is then termed.

In some foundries the tap hole is formed in a ganister brick made in a wooden mould and dried, others using a similar block of material similar to a firebrick. The same remarks apply to the slag hole, and such a brick is specially advisable when the slag hole is left open for long periods. Again, other foundries make both slag and tap hole in moulding sand, but this should not be done except on short blows.

End of Blow

When it is considered that sufficient metal has been charged and the metal has dropped a little below the charging door, it is advisable to reduce the blast pressure, again further reducing the blast as the charges sink lower until only about half the blast pressure is operating. This is to avoid injury to the lining by the hot gases which have not been cooled down as previously due to passing through the charges. When, by inspection at the tuyeres, melting is judged to have been completed, the blast is cut off and preparations made for emptying the furnace.

All metal remaining is drawn off; the tuyeres are opened and the bottom dropped, or, in the case of a solid bottom, the coke remaining is drawn through the breast or back opening. Any adhering slag visible through or in the tuyeres is cleared and the deposited coke and slag cooled by water from a hose. The benefits of correctly building up the cokes in the breast opening will then be visible. If they have been allowed to project too far outwards into the breast opening, the result will be seen in a quantity of adherent slag on the sides and arch of the brickwork. Removal of this may cause damage to the brickwork and compel renewal to be made at this point.

Blast Pressure

The blast pressure referred to is that indicated on a water gauge, but this method is not the best. The best measure of the blast is the weight of air entering the cupola, for it is obvious that if all the tuyeres were blocked, the pressure on a water gauge might register a correct figure, yet little, if any, air might be entering the furnace.

Again, each pound of coke representing so much carbon must have about 11 lbs. of air to provide sufficient oxygen for combustion, and as volume of a given weight of gas depends on its temperature, even a volume gauge is not accurate unless corrections are made for prevailing temperatures. A cub. ft. of air in cold weather contains more oxygen than 1 cub. ft. of air in hot weather, but 1 lb. of cold air contains just as much oxygen as 1 lb. of hot air, hence the need of some means of determining weight delivered rather than volume delivered, or information that a pressure of so many ounces exists in the blast belt.

About 10.87 lbs. of air (which contains 23 per cent. by weight of oxygen) are required for complete combustion of 1 lb. of coke containing 93.44 carbon, 1.22 sulphur and 5.34 ash. This represents about 142.8 cub. ft. air at 62 deg. Fah.

In the example given, the sulphur is on the high side, a normal foundry coke having about 0.6 to 0.8 per cent. sulphur. In cases where the sulphur is excessive it may be reduced in the iron by the use of soda ash.

Calculation of Mixtures

What follows shows the calculations of proportion of each of three pig-irons to give specified percentages of silicon and manganese in the charge.

		Silicon. Per cent.	Manganese. Per cent.
Pig-iron	A	3.0	0.5
,,	B	2.5	0.75
,,	C	2.0	0.9
Desired composition	D	2.4	0.75
Weight of charge	M	= 1,000 lbs.	

By means of the graph (Fig. 1) it is found that the desired composition can be obtained from the three pig-irons above. In all the equations below, the letters A, B and C represent the respective proportions of A, B and C pig-irons.

Balance for Silicon

$$3.0\,A + 2.5\,B + 2.0\,(M - A - B) \ldots = 2.4\,M$$
$$3.0\,A + 2.5\,B + 2.0\,M - 2.0\,A - 2.0\,B = 2.4\,M$$
$$(1)\quad 1.0\,A + 0.5\,B \ldots \ldots \ldots \ldots = 0.4\,M$$

Balance for Manganese.

$$0.5\,A + 0.75\,B + 0.9\,(M - A - B) \ldots = 0.75\,M$$
$$0.5\,A + 0.75\,B + 0.9\,M - 0.9\,A - 0.9\,B = 0.75\,M$$
$$-0.4\,A - 0.15\,B \ldots \ldots \ldots = -0.15\,M$$

Multiply both sides by -1 .. .. (2) $0.4\,A + 0.15\,B$ .. .. $= 0.15\,M$
Repeat .. .. .. (1) $1.0\,A + 0.5\,B$ .. .. $= 0.4\,M$
,, ... (2) $0.4\,A + 0.15\,B$ .. .. $= 0.15\,M$
(2) $\times 2.5$ gives .. .. .. (3) $1.0\,A + 0.375\,B$ .. .. $= 0.375\,M$
(1) $-$ (3) ,, ... (4) $0.125\,B$ .. .. $= 0.025\,M$
(4) $\times 8$,, ... B .. .. $= 0.2\,M$
Repeat .. .. .. (1) $1.0\,A + 0.5\,B$ .. .. $= 0.4\,M$
Substitute terms of M for value of B .. $1.0\,A + 0.1\,M$ .. .. $= 0.4\,M$
$1.0\,A$ .. .. $= 0.4\,M - 0.1\,M$
A .. .. $= 0.3\,M$
(5) $A + B$ .. .. $= 0.5\,M$
(6) $A + B + C$ .. .. $= M$
Subtract (5) from (6) .. .. .. C $= 0.5\,M$

	Lbs. of silicon.	Lbs. of manganese.
0.2 M = 200 lbs. B .. .. =	5	1.5
0.3 M = 300 lbs. A .. .. =	9	1.5
0.5 M = 500 lbs. C .. .. =	10	4.5
1.0 M or charge of { 1,000 lbs. contains	24 lbs. Si	7.5 lbs. Mn
100 lbs. ,, ...	2.4 ,,	0.75 ,,

Which equals the respective percentages required, namely, 2.4 per cent. silicon and 0.75 per cent. manganese.

DISCUSSION

Mr. Royle asked whether, with a small furnace, and making seven to nine tons each day and about 10 to 12 cwts. each tap, the charges would be separated. The first metal was supposed to be common, and the second special cylinder quality.

Separation of Charges

The Lecturer said that with such a small amount as 10 tons, it would be difficult. The usual way, when there were different types of metal following one another, was to allow—assuming 10 cwts. of a certain type of metal was required—slightly more than the 10 cwts., and also with the following charge a similar allowance must be made. In any case, it was not practical to make about eight or nine taps at 10 cwts. a time during a blow. It was far better to blow one day for one type of metal, and another day for a second type, or else work more than one furnace.

Removing Obstructions

Mr. Bateson understood that some furnacemen knocked out the slag that gathered in front of the tuyeres, and the speaker had recommended that it should be removed. He would like to know how this was done.

Mr. Andrew explained that when the slag appeared, it was visible through the tuyeres, and by lifting up the cover of the tuyere, a $\frac{1}{2}$-in. or $\frac{3}{4}$-in. bar with a hook at the end could be used to remove it. If left it would gradually accumulate, and grow until the melting was interfered with, and perhaps stopped. A mixture of coke, slag and iron was formed which was more difficult to melt than iron.

Mr. A. Boyes, referring to Mr. Royle's remarks as to his putting a special cylinder quality in between the two charges of common iron, confirmed that this was not sound practice. It was best to insert a separating charge.

Mr. Andrew said that if there were only 10-cwt. tappings it made matters very difficult. In that case he failed to see the necessity of preceding it by any metal other than what had been run down the spout to warm it, if the

furnace was melting hot when the initial low temperature would not matter. There was no necessity for running pig-iron through first, if it was run into a ladle.

What is Common Iron?

The Chairman (Mr. Hopwood) said it was time the expression common iron was eliminated. It seemed the practice in foundries to speak of soft iron used for general purposes as common, and he thought the sooner they lost the idea that there was such a thing as common iron the better it would be. As had been remarked, what was common iron in one foundry might be very high-class iron in another. With regard to the mixing of the iron, he thought that there was no reason why one should not cast a number of different charges, if a means could be found of separating the small amounts of irons which were probably left over. As Mr. Andrew had pointed out, the usual course was to put the surplus iron resulting from the change from one charge to another or the change from one cast of iron to another, into castings which were not quite so exacting in requirement. Some foundries, of course, blew down completely all the iron which the furnace contained before they put on a fresh class of iron. That was relatively expensive, and he did not think that, in the usual class of foundry, it was necessary.

A Practical Example

Mr. Andrew said he would like to add that the foundry he had in mind had a first charge of 30 cwts., the normal charge being 1 ton. The next was about 50 cwts. to 2 tons of iron, which would contain about 2.5 per cent. silicon, following the 2 per cent. silicon. The next after that would be a special iron—actually they were all special grades. Two tons of 2.5 per cent. Si iron went to one section of the shop. Then another ton, which included some of the 2.5 per cent. Si iron, and some of the following, which was 1.5 per cent. Si iron, and "class" iron too, were put into another job, all into one casting, and 1 ton into another casting. After this 3 tons, all that 1.5 per cent. silicon was put into castings which were certainly "class" castings, so that for the 2.5 per cent. silicon they charged 50 cwts., and for the 1.5 per cent. silicon there were 70 cwts. charged when they wanted respectively 2 or 3 tons. That was found very convenient, but it was difficult in a foundry where the quantities were only small to have such variety.

Direct Shanking

A Member asked whether, for small castings, it was preferable to shank direct from the cupola or to interpose a mixing ladle.

Mr. Andrew said the governing factor was the thickness of the castings. Quite a number of foremen use bogey ladles, which took the metal 100 yds. or so, and then filled shanks. This gave a more representative mixture than by direct shanking, but that depended on the size of the charge. If charging 10-cwt. charges in a 24-in. cupola, they might expect pig-iron one time, scrap another time, and anything a third time. The bogey ladle method should regularise the composition, but it would not be definite even then.

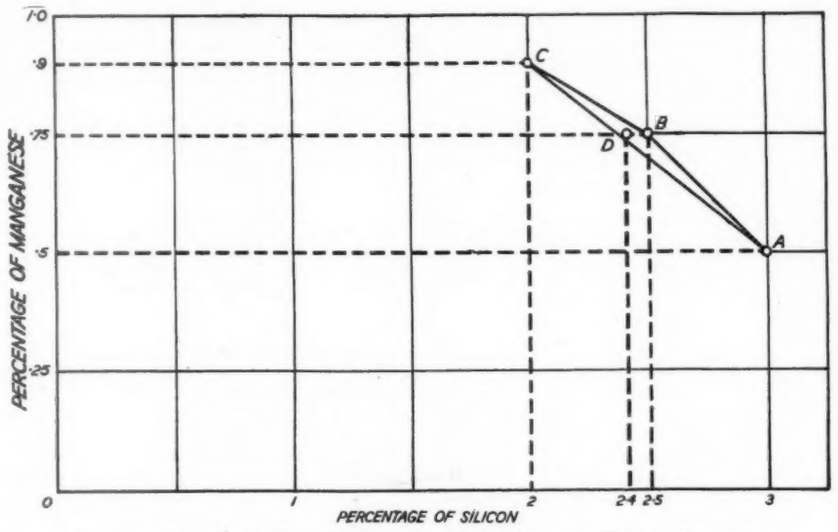


Fig. 1.—Graph for Determining the Composition of Cupola Charges.

By plotting the intersection of the Si and Mn contents in the three pig-irons, A, B and C, and joining them to form the triangle shown, it is found that as the desired composition D falls within the triangle, it is possible to make up a charge, having that composition, from the three irons in question.

Metal Appearance Times

Replying to Mr. Bateson, who said that while the speaker had given a quarter of an hour for the flow to start, he had known foundries where it took three-quarters of an hour, Mr. Andrew said that there was a reason for the variation in time. If ever the metal came down before a quarter of an hour, his bed was too low. When it took longer than a quarter of an hour, the bed was too high. If it took three-quarters of an hour to get metal started, the foundry was blowing a deep bed of coke. The size of the cupola did not make very much difference on that point.

Another Member asked if the lecturer could indicate the best way to tap out so as to avoid accidents.

Mr. Andrew said the best way was to let the furnace tap out itself. They should pick the clay away and not try to pick a hole in the tap hole. If the clay were taken away from the front, the metal would come away itself quietly.

Plant and Production Methods of Triplex Foundry, Limited, Tipton

(*Continued from page* 333.)

dust and adhering shot; it then makes its way through the wall screening the two sections and runs parallel to a line of spraying booths.

The millroom in which the enamel for the spray booths is prepared has already been described in the Journal (see August 5, 1937, pp. 107-108).

Spaced between each pair of booths are large circular tables, pivoted and capable of being turned by hand. On to these tables an operative lifts work from the conveyor. Each booth deals with some particular colour or finish, shading or mottling for example, and work is transferred to a table serving the appropriate booth. All booths are equipped with exhaust fans and atomised enamel drawn away by these is trapped and recovered for further use. Spray guns similar to those used for paint are employed to coat the surface of the article with a water-suspension of finely ground enamel. Certain effects, such as mottling or shading, are obtained by partially superimposing two or more sprayed coats of different colours.

It might be pointed out here that since vitreous enamels are a type of glass and are in no way related to oil paints or enamels, it by no means follows that the colour of the sprayed coat bears any relation to that of the fired coating. Colours are developed by firing, due to interaction between the frit and the colouring agent blended with it. Thus, in the unfused state, a black vitreous enamel is dark grey.

The finish-sprayed components are next transferred to another conveyor feeding a drying oven. This is provided with two heating units, consisting of gas-fired air heaters and propelling fans. On emerging from this, the coating is still fragile to the touch, but does not powder or flake off while being handled during transference to the muffle.

Firing the Enamel

Fusing is carried out in Gibbons coal-fired muffle furnaces of the over-fired type. The muffles measure 12½ ft. by 6 ft, and are 5¾ ft. high at the arch. They are lined with carborundum. Temperature control is by means of Electroflo pyrometers. For supporting the work during firing Cronite perrits of the hanger and saw-tooth types are used.

The control of the atmosphere in the muffle is of the highest importance, as sulphur-bearing gases in all but the smallest traces exert an extremely harmful effect on the enamelled surface. Similarly, great importance is attached to the uniform heating of the charge, and to the absence of inordinate temperature gradients in the muffle. In this regard, coal-fired furnaces of the over-fired type have proved themselves in every way both economical and reliable.

After removal from the muffle, the enamelled components are allowed to cool down in air; they are then transferred to a separate store, from which they are issued to the assembling shop. In so far as unsatisfactory work is concerned, this may sometimes be touched up and refired, but cast iron is usually sandblasted to remove the enamel, and then re-sprayed and refired. In the case of sheet, no such recovery is attempted.

On the assembling section, facings, back plates, bars, and other components are checked up on jigs if necessary and erected to form the complete article. This itself is tested for flatness of base and for uprightness on a surface plate to ensure easy fitting and ease of replacement of damaged parts subsequent to sale. The assembled job is now run on a conveyor to a spraying booth, where the back is given a coat of stove enamel to protect it from rusting, and where, in addition, certain models which are not faced with vitreous enamel are treated with stove

(*Concluded from next column.*)

enamel both back and front. Still on the conveyor, the stove now passes through the hands of operatives who clean it down, and so to a gas-heated stove for drying off.

On emerging from the drying stove the finished grate is lowered by means of a press-button operated electric lift to a truck-way from which it is picked up as required by the dispatch department. The average output is about 700 grates per week.

The writer wishes to thank the directors of Triplex Foundry, Limited, for permitting him to visit the works, and for the courtesy extended to him during his inspection of the plant.

(*Concluded in previous column.*)

D

East Midland Foundrymen's Opening Meeting

The East Midlands Branch of the Institute of British Foundrymen opened its new session on October 2, when the proceedings included a works visit in the afternoon, the delivery by Mr. W. T. Evans of his Presidential Address, and the presentation of a Paper by Mr. H. Bunting on "The Vocational and Technical Training of the Foundryman."

The works visited were those of Aiton & Company, Limited, of Derby, and a party of 72 members were received by Sir J. Arthur Aiton, K.B.E., Major Aiton, and members of the staff. They were conducted over the foundry and workshops specialising in all types of iron and steel pipe specials, and at the conclusion of the visit tea was taken in the works canteen.

A vote of thanks was proposed by the Branch-President, Mr. W. T. Evans, who said that he had been astounded by the great amount of skill required in the manufacture of pipes by the special process shown. Mr. H. Bunting seconded the vote.

Major Aiton, responding, said he was very glad that the visitors had been interested. He agreed that the firm's specialised processes required great skill, as they used no patterns in the manufacture of any of the castings. They were rather averse to the modern tendency in production foundries where the system was to provide almost perfect patterns for use of unskilled labour. In order to keep a supply of skilled labour the firm had their own training school for apprentices.

The members then adjourned to the Derby Technical College for a technical session.

Mr. H. Bunting said it was a pleasure to him to welcome members to the opening meeting of the session, and he sincerely hoped that the members would attend the whole of the meetings in large numbers. He then introduced the Branch-President, Mr. W. T. Evans, who, he said, had the second experience of President, and he felt sure the Branch could not have made a better choice.

Mr. Evans' first duty was to present to one of his own staff, Mr. S. Horton, a diploma awarded to him for his Paper "Patterns and their Relation to Moulding Problems." This Paper, said Mr. Evans, had been Mr. Horton's first attempt, and he was again presenting a Paper to them during the session. It was also announced that last year's prize had been awarded to Mr. H. Reeve, of Leicester.

PRESIDENTIAL ADDRESS

Mr. Evans then gave his Presidential Address, in the course of which he said:—

Mr. Bunting and Gentlemen,—Looking back to my last term of office more than a decade ago, I can see the great changes and definite progress made by the Institute and especially by the East Midlands Branch. Your Past-Presidents have not lost interest, most of them are regularly in attendance at the Council meetings and lectures, and as an example of the work done by the Branch members the success of the 1937 conference held in Derby will be a lasting credit to the Institute in this area. The Branch is fortunate in having Mr. Bigg as President of the Institute, Mr. S. H. Russell to hold several responsible offices in the General Council, and it is excellently represented on the Technical Committee by Mr. P. A. Russell and Mr. A. E. Peace. The Lincoln Section is now making progress, and all who can should join with the Sheffield Branch in a visit to the works of Ruston & Hornsby on October 29.

This session the Branch Council has decided to have a series of educational lectures which it is hoped will prove progressive and entertaining, covering a large section of founding. An effort was made to include steel founding, but the programme for this year could not be extended to include this feature, but this subject will be in next year's programme, as a promise has already been received from a Branch member to give a Paper.

At each lecture during the session members will be able to ask as many questions as time permits, and it is requested that if any member is unable to enter into the discussion, or is absent, he will write direct to the lecturer, who will be pleased to give him a written reply. These replies will be read in the last lecture of the session, which will be a *résumé* of the session's lectures and discussions.

At this lecture Mr. Sanders is to sum up the series of Papers and bring out the chief points of the discussions, and also give his opinion of the lecturers' written replies. In addition to this I have requested Mr. Sanders, together with Mr. Bunting, to make a record of those who enter into the discussions, and as President I propose to give a prize, on their recommendation, to the most active member of the Branch during the session. The prize to be presented is a copy of Bolton's "Cast Iron," which in my opinion is an excellent treatise on iron, and of great value to any foundryman.

A suggestion which it is considered would enable members to obtain the greatest and most lasting benefit from the session's programme is to publish the lectures in the form of a brochure, copies of which would be presented gratis to all members.

There are in the Branch members who are practical specialists in most branches of the industry, and it is an opportunity as a Branch of the Institute to place on record the opinions and experiences of those members who have given their time and efforts for the benefit of all concerned, especially for the younger and future members.

With this object of using the new session for the interest and improvement of all the members, the Council has decided to have a series of lectures in which it is hoped to cover most of the everyday foundry practices, and also to provide opportunity for comments on the education of the young foundryman.

Education

Personal ideas on this subject may be unorthodox, but the more I see of present-day methods, the more I am convinced that there will be drastic changes in the near future. I feel that if our young men have all the education they can absorb and have not the will or desire to work with their hands as well as their brains, all education is lost. I consider the greatest loss to industry to-day is due to the lack of leaders or men who have the necessary education and interest in the work for itself to help and teach those who cannot be other than excellent workmen producing the common needs of life for the community. The most useful and reliable young men now coming along are those who are continuing their education in the Technical College by day and evening classes, and I sincerely wish that more employers would take advantage of the facilities provided, as it would greatly benefit industry in the future. The Institute has for its motto, "Science hand in hand with labour," and if we support this we stand some chance of our efforts benefiting mankind.

Mechanisation

During the past ten years many foundries have become mechanised or semi-mechanised with varying degrees of success, scrap figures as high as 90 per cent. and as low as 2 per cent. being quoted for fairly intricate castings.

Most of the ideas of mechanisation in foundries seem to be based on the engineers' conception that there is not much output being obtained from the foundry unless there is endless movement. This is laudable in a certain set of conditions, but quite inane and useless under other conditions. To put it plainly, it is senseless to run an empty train, as neither speed nor time achieve any purpose other than wear and tear, and to make a success of mechanisation or continuous output conditions must apply which create a continuous quantity demand for the articles to be produced, also that the metal poured will suit the castings; it is certain that section, size, etc., must be in relation to the moulds on the merry-go-round. Of course, the engineer is of the opinion that he has speeded up the foundryman and shown him where to "get a move on," but if there had not been the advance in metallurgical practice the engineer's moving would have been a failure. As an example of engineering movement, when visiting a merry-go-round foundry, I saw castings being machined, and when inquiring the reason for this, it appeared that the castings were made in an iron which had to be close for wearing properties, and of necessity gave a hard white fracture in thin sections. The castings had been designed of such different thicknesses that there was an outlet pipe which could not be machined unless it was thickened up to lengthen its cooling time to allow graphitisation to take effect; no provision had been made in the engineering lay-out for this operation, and therefore the castings were failures and unless the foundryman had machined the extra metal off the castings movement was stopped.

I have also known large bedplate castings to be refused by the machine shop because the foundry insisted on large machining allowances, owing to camber in the casting by cooling stresses. These are facts which we as foundrymen have still to face and educate the users of castings to meet such difficulties.

I have visited several mechanised plants recently; some were working admirably and with others I could not see the reason for their running, as I feel sure the capital and depreciation charges per ton were enormous. There is to-day a move to standardise castings, and here we shall have to make provision to overcome the tedious repetition movements. Some form of continuous casting will be necessary, but let us try to provide room for the men to work in daylight and not in some of the nightmare conditions now existing. There is still room on the globe without making foundries so much like trench warfare.

Vote of Thanks

Mr. P. A. Russell said he had much pleasure in proposing a vote of thanks to Mr. Evans for his address. The remarks on mechanisation had been very interesting.

Mr. R. Spriggs, who seconded the vote of thanks, said he would not support the President in all his remarks about mechanisation. He looked into it from the engineering side, and foundrymen considered that the engineers knew all about running those plants. The engineer had to put in the plant, but the man who had to make that plant a success was the foundry manager.

Mr. Evans briefly responded, and then called upon Mr. H. Bunting to present his Paper "The Vocational and Technical Training of the Foundryman," which is printed elsewhere in this issue.

Soviet Purchases of Machinery

In the first nine months of this year there was an increase of 118 per cent. in the value of Soviet orders and purchases in the United Kingdom, as compared with the parallel period of last year. This year's total was £16,814,003, while the 1936 total was £7,684,945. The largest advance was in purchases of machinery and equipment, which amounted to £6,922,033 in the first nine months of this year, against £348,862.

Effects of Corrosion on Cast-Iron and Steel Piping*

By LUDVIK OLSANSKY

One of the most important points to resolve, the question of the non-mechanical or corrosive action on the surface and in the inside of the walls of cast-iron and of steel pipes, does not reside only in the knowledge of the reasons which may be the origin:—(*a*) Chemical; (*b*) electro-chemical; (*c*) electrolytical, but, more particularly, in the knowledge of the various interdependencies and processes of the effects in considering the various physical and chemical properties of the two materials in question.

On account of the importance of this question, especially from an economic point of view and from that of security of the installation, par-

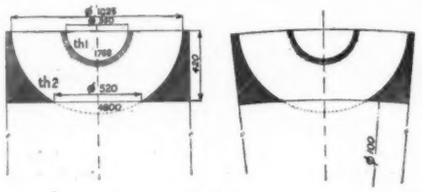


Fig. 1.

ticularly in parts where special circumstances (mechanical influences of the soil, etc.) do not call for it, the writer has decided to study progressively the phenomena described hereafter.

Introduction

The corrosive action and its magnitude must be carried out and determined, in order to have some value of comparison and allow of the evaluation of the material, under identical conditions as far as this is possible from a technical point of view. That is to say, it must be ascertained with pressure, temperature, concentration and uniform quantity strictly defined, and with the corrosive agent acting upon a unit surface which, in this case, theoretically represents a point only, and this action must be made separately. Moreover, it is necessary that the measure of the action on the material under inspection be made in the state in which it is after formation of the protecting layer; it is especially by machining the surface that one

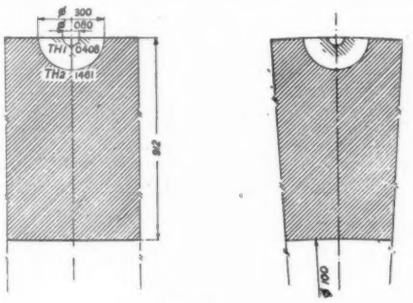


Fig. 2.

obtains results which are out of proportion to permit giving an appreciation.

By starting with the aforementioned conditions of comparison, the writer carried out his own tests in order to be able to study objectively both kinds of materials for pipes, as regards physical and chemical properties, and to determine the depth and rapidity of the process of corrosion *vis-à-vis* with the thickness and structure of the walls.

* A Paper read before the International Foundry Congress in Paris.

Destruction of pipes made of cast iron and of steel as observed by the writer was a chemical reaction. The action was limited to the contact surface of the material and the corrosive agent.

Description of Preparatory Work

First of all, the laboratory was controlled in such a way that a constant temperature of 20 deg. C. could be maintained, which temperature was achieved by heating it through the use of an automatic regulator. The evolution of the heat was noted. The lighting of the laboratories was such that it could be adapted to all requirements. Even ventilation was installed in such a manner that it could be regulated.

The other work consisted in preparing the material which had to be examined. On one hand the author took cast iron and steel plugs measuring 100 mm. in diameter and pieces of pipes which had been cut in the centre of the length of the pipes, each piece measuring 150 mm. in length. In order to be sure about the puncturing action at the one point required, it was necessary to make other preparations as well. Taking the pieces of cut pipe, cardboard ends were added and the pieces thus prepared were completely immersed—bottom downwards—in melted paraffin, at the same time as the plugs, so that when they were withdrawn and after cooling a protecting coating was formed, which adhered closely to the surface and fulfilled its purpose.

As a corrosive agent the author used a 5 per cent. nitric acid solution. To guarantee even concentration of the solution, this was first of all prepared in a large glass basin, it was well mixed, and only after 24 hours was 3.5 litres of the solution poured by means of a necessary jar into each test flask. The latter, 250 mm. in dia. and 120 mm. high, were made of glass.

To measure the effects of the corrosion, a very simple apparatus was used which allowed the fixing of the object being tested in the required position, and the measuring of the depth of the pits produced by the above mentioned reagent, with 2 axes (perpendicular) one above the other.

Tests

When everything had been prepared, the layer was destroyed by puncturing at one spot of the test-bar always placed rather near the bottom (in this case 30 mm. from the bottom), so that this spot when bared was constantly under the influence of the reagent. Then two samples were placed for purposes of comparison in two of the test flasks, with the bottom downwards, at intervals of five minutes. The corrosive action was interrupted every two days just for the amount of time required to measure. During the reagent's action on the samples, the temperature, which averaged 20 deg. C., was taken and a note was made of the time required from the start until the end of the test. As the destruction of the two samples being compared was going on almost simultaneously, it was not necessary to take into consideration the very small variations in pressure and their influence which could not be measured, by making a note of the pressure alone..

To measure a sample, five minutes were required. When the pipes came out they were dried on the surface and inside the pits caused by the corrosive reagent with filter paper. At the spots which had been attacked, the remains of the corrosion were removed with forceps or some kind of a knife so as not to spoil the surface which gave the shape and the dimensions. Samples thus prepared were laid with the attacked part on top on filter-paper, then placed in the vice of the measuring apparatus in order to measure the depth of the attacked parts following the two perpendicular axes one above the other.

The measurements carried out with both kinds of material as long as it was not defective have shown that the shape of the openings or dents are either hemispheric or hemispheric with a slight deformation, but never conical. Fig. 1 shows the shape of the openings which were caused by the action of the 5 per cent. solution HNO_3 during 12 days at an average temperature of approximately 20 deg. C. for two steel pipes th_1, th_2, and Fig. 2 shows the pits made in the two cast-iron pipes TH_1, TH_2, produced under the same conditions as for the steel pipes. Fig. 3 illustrates the shape of the pits in the cast-iron pipe, marked TH_1, and the opening of the cast-iron pipe TH_2, caused by the action during a period of 29 days of the

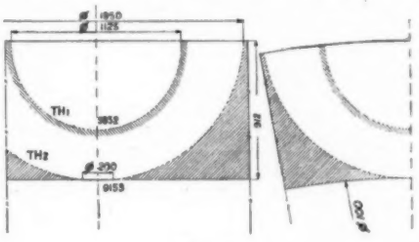


Fig. 3.

5 per cent. solution of HNO_3, at an average temperature of 20 deg. C.

The speed of destruction of steel pipes th_1, th_2, as well as that of cast-iron pipes TH_1, TH_2, is given in Fig. 4. On this graph is shown by the horizontal axis the time in days; on the vertical axis is shown in mm. the maximum depths of the pits caused through the action of the 5 per cent. HNO_3 solution at a temperature of approximately 20 deg. C. The thickness of the walls of the steel pipes th_1, th_2, and that of the cast-iron pipes TH_1, TH_2, are limited by the axis and by parallel lines with this axis with cross hatchings. The lines drawn in black indicate the maximum depths of the pits in steel pipes th_1, th_2, produced by the action of the 5 per cent. HNO_3 solution at a temperature of about 20 deg. C. with reference to the length of time of the action. Again, the dotted lines indicate the depth of the pits in cast-iron pipes TH_1, TH_2, brought about through the action of the 5 per cent. HNO_3 solution at a temperature of approximately 20 deg. C. on account of the length of time of the action.

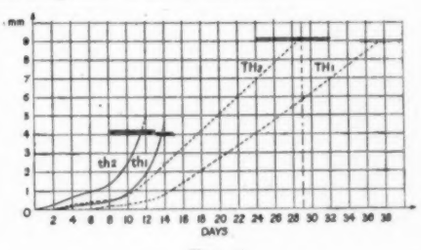


Fig. 4.

From Fig. 4 it will be seen that the connection between the length of time required completely to pierce the cast-iron pipe TH_1 and that for the steel pipe th_1 is as follows:—

$$\frac{T}{t} = \frac{29}{11.6} = 2.5$$

and for the cast-iron pipe TH_2 and the steel pipe th_2:—

$$\frac{T}{t} = \frac{37.6}{13.74} = 2.75$$

which shows that the time necessary to pierce cast-iron pipes by means of the aforementioned

process was longer than was required with steel pipes and it worked out at 2.5 to 2.75 times greater.

By the shape of the maximum depths of pits as shown in Fig. 4, it will be noticed that corrosion of cast-iron pipes, 100 mm. in dia., is slower than corrosion of steel piping of exactly the same diameter and under the same conditions, even when taking into account the thickness of the walls. With the help of this figure other graphs can easily be drawn showing average speeds of progress on an average of corrosion, time, and thickness of the pipes' walls being also taken into consideration.

Under identical conditions the author has also carried out four supplementary tests on pieces of cast-iron pipes (under the action of a 5 per cent. HNO_3 solution, and with a temperature of approximately 20 deg. C.), four tests on cast-iron plugs, four tests on pieces of steel piping and four tests on steel plugs. The maximum depths of pits made in the intervals varied during these tests for the pipes and the plugs in cast iron, with one exception, between the maximum values of pits marked TH_1, TH_2, and as regards pipes and plugs made of steel—between the maximum values of dents in the pipes marked th_1, th_2.

The other experiments consisted in metallographic tests made in order to discover the connection between the speed of corrosion and the structure; these investigations proved that the resistance of cast iron to the action of 5 per cent. HNO_3 solution was so much more because:—(1) The casting was more dense at the surface and of a finer grain; (2) the skin on the cast iron was thicker and more even, and of "ledeburitic" structure'* and that this part merged more gradually into the graphite part; and (3) there was more combined carbon and the graphite carbon was finer and more even.

On the other hand, resistance was less because: (1) The surface was not so dense, was more porous and consisted of a larger grain size; (2) the cast-iron skin was thinner, or was damaged, or showed a brusque change of the ledeburitic structure to the graphite structure; (3) there was less combined carbon and the graphite was larger, especially if the latter formed continuous and thick lamella, and (4) there were more impurities and segregations.

Resistance of steel pipes increased with:—(1) An increase in the smoothness density and fineness of grain of the rolled skin; (2) an increase in thickness of the layer of magnetic iron oxides and the more the change of this structure to that with greater carbon contents and manganese was gradual.

On the other hand, resistance was less:—(1) The more the surface was rough and uneven, less dense and with larger grain; (2) the thinner the protecting coating was (consisting of magnetic oxides of iron) or the more damaged it was and that the structure of the surface merged all the more suddenly into the part containing carbon and manganese, and (3) because there were more impurities at the surface and inside the pipe.

Chemical Composition

The chemical composition of the samples which were tested varied for the pieces of cast iron pipes and the plugs between the following limits:—T.C, 3.67 to 3.71; C.C 0.88 to 0.97; Si, 1.64 to 1.83; Mn, 0.61; P, 0.19 to 0.45; S, 0.075 to 0.08 per cent., and for the pieces of steel pipes and the plugs the variation was:—C, 0.38 and Mn, 0.80 to 0.73 per cent.

Schmit,[2] who has also studied this question from the chemical and metallographic points of view, obtained various results, but he found that the chemical composition and the structure have no influence at all on corrosion. The results obtained by tests and the experiments already outlined show that the progress of corrosion is in fact influenced not only by the chemical composition but also by the structure. The differences should be immediately noted by the metallographic method because it generally happens that during the action of the corroding reagent the traces of the real reasons are lost.

As a matter of interest in this connection, it should be pointed out that if one examines places on one casting, about 5 cm. apart from each other, and at the same height above the bottom, having the same chemical composition, and being subjected to the same conditions at the beginning of the corrosion, these places show considerable differences (see Fig. 5). The progress of corrosion at one point caused by the 5 per cent. solution of HNO_3 at a temperature of approximately 20 deg. C. is indicated at A,

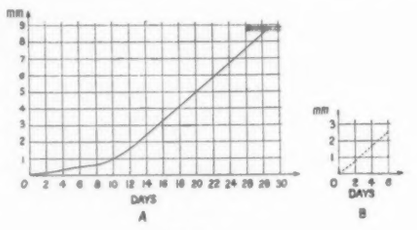


Fig. 5.

Fig. 5. The progress of the same corrosion taking place at another of the places on the same sample subjected to the same conditions is given at B, Fig. 5.

It was later learnt that the workman had put this casting, having a protecting layer which was thicker, on red-hot coke and that by the heating of the surface at the spot where it had touched the coke, the ledeburitic structure of the skin was destroyed, which could be confirmed metallographically. The corrosion operated at the beginning with almost the same rapidity as on the surface. This indicated the important fact that it was not advisable to heat the pipes rapidly to a high temperature before coating them, but preferably progressively at low temperatures.

Piwowarsky maintains in his articles published in "Gas u. Wasserfach,"[3,4] that the precipitation of graphite iron is of no importance in regard to corrosion. Further on in the same article[4] and then in another article which appeared in the same journal,[5] he stressed the importance of the cast-iron skin.

The above tests have shown clearly the importance and influence of the form of carbon on the resistance to corrosion of the skin. This skin shows a greater resistance if the carbon is completely or largely in a combined state.

Dr. Sarek definitely states in an article[6] that large graphite lamella facilitates corrosion, this showing itself by the piercing and destruction of the cast iron. An unfavourable structure increases corrosion, as is clearly proved by the results obtained in the tests on pipes.

Friedrich Kuckuk[7] shows that the resistance of cast iron to rust depends on the contents of combined carbon, because the greater the content of combined carbon, the greater is the resistance to corrosion. For this reason cast-iron pipes are to be preferred in the case of corrosive soil.

The Czecho-Slovakian Standards Association points out in the tentative standards,* steel pipes are more easily corrodible than cast iron.

Dr. R. Urban[8] wrongly states that the corrosive action of acids is equal on the welded pipes as on cast iron, because the comparative tests have shown a greater resistance for cast-iron pipes than for steel.

The Bureau of Standards[9] has published the results of tests made on cast-iron and steel pipes in order to decide the corrosive influence of various soils. With this object, a large number of cast-iron and steel pipes were buried adjacently in various localities. These tests showed that after a fixed period the results obtained were not conclusive. Such tests must be considered as quite useless, because they do not conform in any way to true conditions of comparison. The author is adamant in his belief that, in the main, the same material may be quite intact at one place, whilst at another point a little further on strong corrosion may show up.

Dr. E. Neumann[10] says that three forms of corrosion have been distinguished:—(1) Uniform destruction of the surfaces; (2) punctured corrosion in places; and (3) spongy graphitisation of the cast iron.

It is very important to point out that these three forms may arise from the same cause, but under different conditions, as the author's tests have shown. If the corrosive reagent acts on a very small surface of a material, the theoretical point, there is a puncture-type of destruction. By the constant action of the corrosive agent the punctured surface assumes a spheroidal shape.

If at various places corrosion arises, one beside the other, they join up in time and give the idea of a destruction of the whole surface, which may also be as dangerous as the puncture-type corrosion, if the quantity of corrosive reagents is sufficient.

In the case where the corrosion product is not sufficiently extracted, it forms deposits between the graphite lamella and because of certain salts it hardens and gives a graphite appearance to the cast iron.

A. Kutal[11] states that the shape at the spots attacked by the spongy graphitisation of the cast iron is very often round, having the shape of a cone of which the point is directed towards the inside of the pipe. There is no theoretical reason for this conical shape, but that in reality the shape is exactly hemispherical or gives the idea of a hemisphere slightly deformed as is shown by the shapes produced in the tests indicated above.

The use of statistics in order to give a general conclusion on the advantages of cast-iron or steel pipes is not sufficient because usually all the conditions influencing the pipes which have been laid are not known.

The author proposes to publish, on completion, the results of his tests. He expresses his best thanks to Professor Pisek, of the Technical High School of Brno, and to Dr. E. Benes for their help in the preparation of this Paper and studies, also to Mr. Bukovanski, Director of the Brno Gas and Electricity Works.

BIBLIOGRAPHY.

1 Bauer. "Gas und Wasserfach," 1925, p. 716. V. Duben. "Plyn a voda," 1934, p. 93.
2 Schmit. "Gas und Wasserfach," 1934, p. 132.
3 E. Piwowarsky. "Gas und Wasserfach," 1929, p. 93.
4 E. Piwowarsky. "Gas und Wasserfach," 1937, p. 91.
5 E. Piwowarsky. "Gas und Wasserfach," 1935, p. 945.
6 Dr. Sarek. "Plyn a voda," 1931, p. 147.
7 F. Kukuck. "Der Gasrohrleger und Gaseinrichter," p. 17.
8 R. Urban. "Plyn a voda," 1931, p. 155.
9 Bureau of Standards. "The Iron Age," Vol. 121, 1928, p. 1806.
10 E. Neumann. "Gas und Wasserfach," 1932, p. 349.
11 A. Kutal. "Plyn a voda," 1936, p. 264.

Statistical Methods of Investigation

According to S. M. Shorodzievsky, writing in "Liteinoe Delo," No. 4, 1937, foundries in the U.S.S.R. have at their disposal an enormous quantity of statistical data relating to the quality of foundry iron, composition of charges, working conditions of melting units, quality of castings, etc., but such data are not very often utilised, showing that in this respect foundry practice is not so progressive as other branches of metallurgy. Practical examples which are given include the sorting of record cards, summation of frequencies, graphs and dot diagrams illustrating a definite relationship between various factors, the determination of the coefficient of correlation and the deduction of equations expressing the relationship between the given factors.

* This is contrary to Prof. Bauer who wrote in "Gas u. Wasserfach," 1925, p. 716, saying that either the cast-iron skin or the mill scale for steel is composed of magnetic oxides, or to Mr. V. Duben in "Plyn a voda," 1934, p. 93, to the effect that cast-iron pipes were well protected against destruction by a very hard iron coating, formed by oxidation of both surfaces of the pipe during casting.

* C.S.N. 1054, 1931, p. 3.

Segregation Phenomena in Lead Bronzes*

By Dr. W. CLAUS (Berlin)

Lead bronzes play an important part in modern engine construction; they are materials ideally suited for the manufacture of bearings to be subjected to heavy fatigue stresses, and particularly for bearings in internal-combustion engines. Such bearings are made either of lead bronze in the massive form, or in the form of a lining cast on to shells of steel, brass, red brass, or tin bronzes. Copper-lead alloys or those containing more than two metals, particularly copper-lead-tin-nickel alloys, are commonly used for this purpose, the last, however, being employed to no very great extent. The percentage of lead in the alloys varies between 18 and 28 per cent.

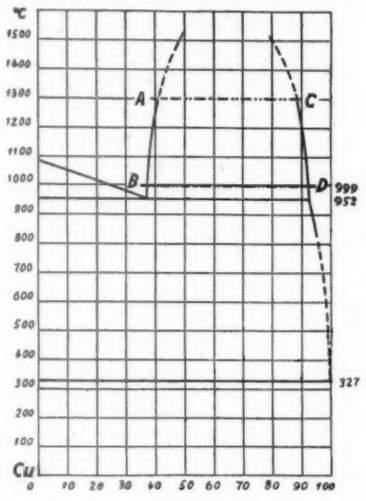


Fig. 1.—Copper-Lead System.

Considering for the moment the straight copper-lead alloys, the manufacture of these is somewhat complicated by the fact that the two metals are only slightly miscible in the solid state as well as in the liquid state at temperatures just above the liquidus.

In general, the segregation which takes place as a result of this low miscibility occurs only with alloys containing more than 37 per cent. of lead. The copper-lead diagram shown in Fig. 1 indicates that during the freezing of these alloys, copper tends to separate out first, followed by the separation of the lead. In practice the freezing process is so rapid that difficulties of this type rarely arise in cast components. Industrial experience has shown that as a rule for these alloys no special manipulative technique is required.

With lead contents above 37 per cent., however, the situation is entirely different. Such alloys, containing lead from 37 per cent. to an upper limit of 97 per cent., show discontinuity in miscibility in the liquid state. An alloy containing, for example, 60 per cent. copper and 40 per cent. lead forms a homogeneous solution above 1,350 deg. C.; below this temperature two phases exist having compositions which at still lower temperatures vary according to the curves *AB* and *CD* (Fig. 1). These two liquid phases can co-exist, uniformly distributed one in the other, down to a temperature of 1,000 deg. C.; once, however, this point is passed, the uniform mixture separates out into two layers, the one containing the most lead forming the lower of the two. The two layers form almost instantaneously.

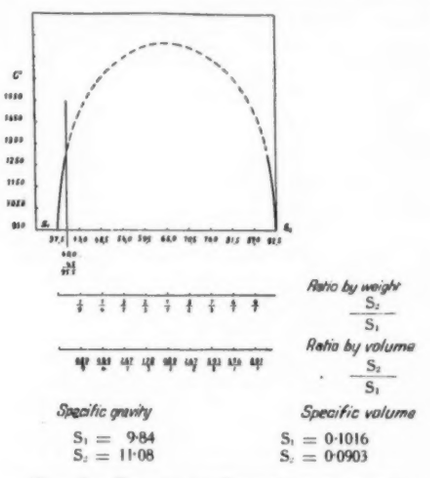
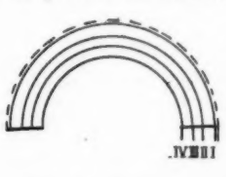


Fig. 2.—Region of Segregation in the Diagram of the Copper-Lead System.

When the alloys are cast difficulties caused by segregation must be expected if some rapid method of cooling, which in effect is so sudden as to prevent the formation of the two layers, be not employed. If the lead content is not too high, up to 40 per cent., for example, the quantity of the layer containing excess lead will be relatively small, as is seen from Fig. 2; thus the inconvenience arising from the formation of layers in castings of this composition is a matter of comparatively small importance. On the contrary, with an alloy containing 45 per cent. of copper and 55 per cent. of lead, very grave trouble may be anticipated.



Layers	IV	III	II	I
Cu	74·6	79·2	76·9	1·4
Sn	10·3	10·6	9·4	5·1
Pb	13·4	8·9	12·9	91·7

Fig. 5.—Transverse Section of Tube of Lead Bronze containing Tin and Nickel, with Table giving the Composition of the Different Layers.

The formation of layers in the liquid condition can be prevented by the addition of a third element, and it is known that the presence of a small amount of nickel entirely inhibits such a phenomenon. In Fig. 3 are given the amounts commonly employed.

Segregation may also occur in lead bronzes containing more than two constituents. It is well established that copper-lead-tin alloys exhibit the formation of layers to a very marked degree (Fig. 4). Moreover, the possible inconveniences caused by segregation can hardly be considered to be of great moment in the foundry, since in general it must be admitted that copper-lead bronzes with more than 37 per cent. of lead find little technical use, although a few rare instances of such use are noted in the literature; in addition the lead bronzes containing other elements and which also exhibit segregation likewise find little practical application.

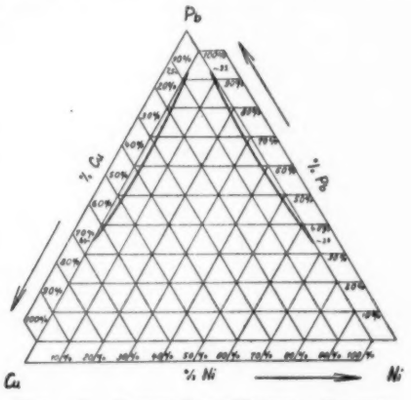


Fig. 3.—Copper-Lead-Nickel System (showing the Limits of Layer Formation).

Mass inverse segregation constitutes quite another aspect. This phenomenon has no immediate connection with the alloying capacity of the metals of which the casting is made, but is explained rather by the fact that during solidification of the alloys a liquid residuum occurs whilst the final solidification is taking place, and that this residuum then passes to those regions where solidification first began. The reason for the migration of the liquid residuum is found in the gas which it contains; this useless constituent consists mostly of hydrogen dissolved in the melt. A cast cylindrical lead-bronze tube in an alloy containing 73.5 per cent. of copper, 15 per cent. of lead, 10 per cent. of tin, and 1.5 per cent. of nickel, on sectioning showed that the inner surface was uniform and smooth, whilst the outside exhibited a soft white layer, which on analysis gave 91.7 per cent. of lead, 5.1 per cent. of tin, 1.4 per cent. of copper, and 1.8

(*Concluded on page* 346.)

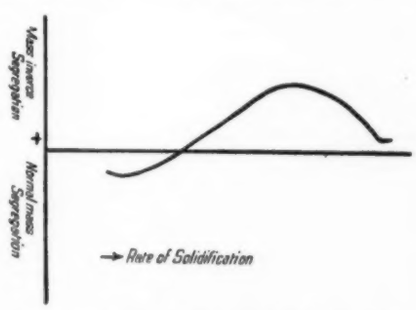


Fig. 6.—Diagram showing the Relationship between Inverse Segregation and Freezing Velocity.

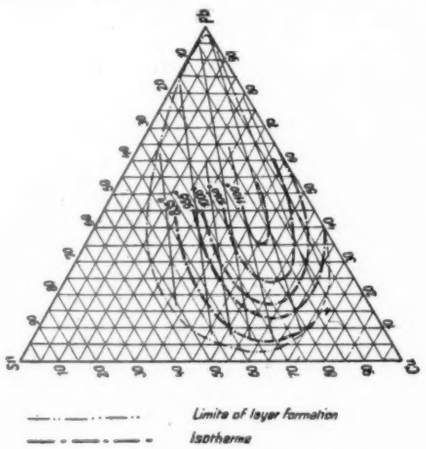


Fig. 4.—Copper-Lead-Zinc System (showing the Limits of Layer Formation).

* Paper read before the Paris International Foundry Congress as a German Exchange Paper.

Benefits of Scientific Control

PRESIDENTIAL ADDRESS TO WEST YORKSHIRE FOUNDRYMEN

The West Riding of Yorkshire Branch of the Institute of British Foundrymen opened the winter session on October 9, at Bradford Technical College, under the chairmanship of Mr. H. Forrest. Prior to the meeting, members dined together as guests of the President, in the Refectory of the College, and Mr. Forrest gave a brief Presidential Address immediately following tea, Mr. F. K. Neath (Past-President) presiding over this part of the proceedings.

PRESIDENTIAL ADDRESS

In the course of his address, MR. FORREST expressed his thanks for the honour of election to the Presidency, and said the members would be aware that the year 1938 was likely to be a momentous one for the West Riding Branch, in view of the fact that, for the first time since its inception, the Branch was to be the host for the Annual Conference of the Institute in June. Mr. Joseph Hepworth, M.P., immediate Past-President of the Branch, was Senior Vice-President of the Institute, and they looked forward to him becoming the first national President from the West Riding Branch.

Much of the success of the Branch had been due to the regular attendance and loyal support of its members, and Mr. Forrest made a special appeal for a continuance of that support this year. The Branch, he believed, was able to show the best percentage attendance of any in the Institute; that was a fine achievement. There were, of course, some members of the industry in the area who were not yet members of the Institute, and it would be a great pleasure to welcome them to the meetings and to take part in the works visits.

Assimilating New Foundry Technique

Developments in foundry technique and science were progressing so rapidly that no man, especially one holding an executive position, could afford to neglect opportunities of adding to his knowledge. For similar reasons, he would appeal to engineering and foundry employers to give the Institute's activities their personal support as well as making its aims and objects known among their staff. The Institute was neither social nor political, but existed entirely for the advancement of foundry science. This could not be but for the benefit of the engineering profession as a whole, whether mechanical, civil or electrical. Mr. Forrest cited the modern motor-car as one of the achievements which metallurgy and improved foundry technique had made possible.

A Metamorphosis

Not so long ago foundries generally were dark, evil-smelling workshops where control of materials was almost absent, although many of the moulders possessed a high degree of skill. As other industries offered more congenial surroundings, it was only to be expected that boys were reluctant to take up foundry work. This state of affairs was changing, and with the development of mechanisation in the foundry, together with better surroundings, the industry was faced with the need for men possessing some mechanical knowledge, foundry practice and metallurgy to fill executive positions. There was also a greater tendency in almost every foundry to appreciate the benefit of controlled metal composition by analysis and also other materials such as moulding sand, also to investigate the use and manufacture of stronger or more wear-resisting metals and to substitute for other materials improved cast-iron alloys. To mention only one example, there was the cast automobile crankshaft. It was only by intelligent study and by hearing other views and opinions that advancement was possible.

Scrap Reduction

Every foundryman knew how gratifying it was to make successfully a difficult casting or to reduce a scrap percentage, and in the majority of cases these achievements were brought about not by accident—and if they were there was little hope of lasting success—but rather by a close study of conditions and an accumulation of data which could be carefully analysed, and from this a plan of campaign formulated. It was here that metallurgical knowledge was of value, but it must not be supposed that pure metallurgical knowledge was meant. This in itself was insufficient in any foundry. Nevertheless, the man who possessed some knowledge of the subject would find his work made easier.

Thermal Control

Many foundrymen to-day used thermometers on their core stoves; they found the use of this comparatively commonplace instrument assisted them to reduce the number of burnt or underbaked cores. It gave more positive indication of the stove temperature or what was happening inside than could be obtained by putting so many shovelfuls of coke on the fire and shutting the damper to a certain chalk mark. The use of pyrometers also was finding a place to-day in more and more foundries. These instruments could be used to check pouring temperatures, and although many foundrymen had certain ideas as to the temperature of their metal, the use of a pyrometer, properly maintained and used, removed in a few seconds any doubt and at the same time provided data to enable the result to be attained at a subsequent time.

Cupola Control

It had been stated that a certain cupola behaved according to a law unto itself—that it had to have special treatment for no very apparent reason; but if all the conditions were investigated—and they could be fairly easily determined—there was often a vast amount of difference in the pressure or volume of the blast, the height of the coke bed, the weight of iron charged, etc. If the fundamental principles of running a cupola were known, it was an easy matter with various modifications to make that cupola conform to its neighbours. Similarly, in regard to faulty castings, which might be caused by a variation in moulding or core sand, or in metal composition and method of casting, it was by study of the conditions which produced either good or bad castings that better results were to be obtained, and a saving of time, effort and money. It was often very hard to be able to put one's finger on the spot which was the cause of the trouble, but by working on fundamental principles the solution would invariably be found much more quickly, and if one added to this an exchange of ideas and opinions, such as were expressed at Institute meetings, this not only would keep the mind occupied but at the same time would raise a discussion which would often start a fresh train of thought or produce an original suggestion which might save much trouble and expense.

Foundrymen could learn much from engineers. The engineers had developed measuring instruments and methods of checking their products which, whilst they might not all be suitable in the foundry, could convey the idea on which foundrymen could themselves develop means of measuring and recording their operations. If the foundry industry adapted up-to-date engineering methods to its own particular requirements, it would cease to lag behind, as it had tended to do in the past.

Vote of Thanks

MR. W. SLINGSBY, proposing a vote of thanks to the President for his hospitality and for his address, complimented Mr. Forrest on the manner in which he had reviewed the situation facing the foundry industry. They would all wish him a happy year in the chair, and the gathering that day was a good augury for the session. He hoped Mr. Forrest's appeal for a combination of all that was best in the craftsman and in science would be worked out in practice by all concerned.

MR. W. PARKER (Past-Branch-President) seconded the vote of thanks.

MR. FORREST, responding, said one must admit that the engineer had many things to his credit which foundrymen might usefully emulate. They had had too much tendency to trust to luck and rule-of-thumb methods. By adopting fully-controlled operations they would secure a greater certainty of effects, and a percentage of scrap reduced to the minimum. There was, of course, always the human element, but the more care they took in measured and recorded operations, the less became the risk of faulty effects from human defects.

The Bradford Conference

MR. S. W. WISE (Hon. Secretary), after adding his congratulations and thanks to the President, said he was particularly delighted that Mr. Forrest was to be the Branch-President in the year when the Institute's annual conference would come to their area for the first time. The conference was to be at Bradford on the three days beginning June 14, and would include a civic reception, a banquet, luncheons and meetings at which important Papers would be presented and discussed. Mr. Wise urged the members of the Branch to do their utmost to attend all of the functions possible.

MR. A. S. WORCESTER (Past-President of the Branch), supporting the secretary's appeal, said one factor of importance in connection with the conference was its propaganda value to the industry in the area in which the conference was held. He believed it had been quite usual for the Branch acting as host practically to double its membership by the staging of the event, and he hoped the West Riding Branch members would see to it, individually, that this was an outcome of the 1938 conference in Yorkshire.

Foundry Machine Production in the U.S.S.R.

Writing in "Liteinoe Delo," No. 4, 1937, A. P. LAKSHIN points out that, as elsewhere, the growth in the aircraft, motor-car and agricultural machinery industries has been the principal contributory factor in the increased output of foundry products in the U.S.S.R. during recent years. Compared with other countries, statistics show that the foundry production in Russia during the second five years' plan has already outstripped that of Great Britain, being only inferior to that of Germany, considering European countries alone. At the end of the second five years' plan the foundry production of the U.S.S.R. will be higher than that of any other European country and will be 36.5 per cent. of that of the United States, and it is expected that this latter output will be reached by the end of the third five years' plan. Admittedly the quality of the work still leaves much to be desired but the quantity of the output is indisputable. The production of foundry equipment presents quite a different picture. Although there has been an increase in the number of foundry machines produced in Russia, yet at the present time, the demand for foundry machines can only be satisfied to the extent of 21 per cent. The backwardness of Russia in this respect is shown by the fact that on the average the number of foundry machines built in the U.S.S.R. is 11.3 per cent. of the corresponding figure for the United States.

Specifications

THEIR USE AND PURPOSE

By H. N. BASSETT,* A.I.Mech.E.

One of the more striking evidences of progress during the last fifty years is the extent to which specifications are used now to control the purchase of supplies and the finish of materials. Many years ago purchasers were content to ask for "best quality" materials only, and to leave the matter at that. What they obtained was either satisfactory, or it was not, and in the latter event they changed their suppliers the next time they wanted to buy that particular line. Advances in scientific knowledge have now made it possible to define more clearly the properties which constitute good quality, and to specify fairly definitely in many cases the requirements to be met in material for particular purposes.

Specifications may be either general or detailed. A general specification is not much more than a description of the material, in which its obvious characteristics, such as shape and colour, are mentioned broadly. This is all that is required in many cases, and no useful purpose is served by amplification. Often, however, it is necessary to be much more precise and greater detail is called for in order that it shall be beyond question that the material will meet all the conditions to which it may be exposed in use. Such detailed specifications are not always easy to prepare and may give much trouble both to purchasers and suppliers if not drawn up with care.

Specifications serve the ends of three classes of people, viz.: the purchasing agents, the users, and the manufacturers, and may be issued by any of the three classes independently. They may be prepared also by bodies comprising representatives of all three classes, and then are generally much more satisfactory as they amount to an agreed compromise between the views of all parties. Such specifications are framed so that whilst the needs of the users are met adequately the capacity and capability of the manufacturers to meet them are not lost sight of, nor is the anxiety of the buyers to obtain cheap materials forgotten.

For a purchasing agent, whether he himself prepared it or not, a specification indicates the kind of material he wants and its application saves him the time taken in examining large numbers of offers and/or samples, whilst the sellers need not submit a wide range of samples for want of knowledge of what precisely is required.

The User's Viewpoint

For an actual user (*i.e.*, designer or manufacturer), specifications show what materials are available possessing certain specific properties, *e.g.*, with metals, high tensile strength, resistance to corrosion or heat, strength at high temperatures, etc.; for oils, demulsibility, resistance to oxidation, good viscosity curves, and so on. He is then able to select the sort of material which suits best the purpose for which he wants it.

For the maker of raw material (*e.g.*, steel, paint, etc.) specifications may be a great help, or a considerable nuisance, according to the way in which they have been drafted. They may help by giving him certain definite standards of acceptance, which being met, he knows his product will be generally acceptable, and able to compete against any made by other manufacturers. On the other hand, specifications which lay down the process by which the steel, alloy, etc., shall be made, or the raw materials which shall be employed in their fabrication, are very often intolerably irksome. Such irritating specifications are usually the result of lack of experience on the part of those who drafted them, and indicate a failure to co-operate with the manufacturer. Sometimes a frank discussion of the objections will secure a revision and the issue of a workable specification.

Metal Specifications

Specifications for metals may be divided into several groups, according to their requirements. Structural steels, for example, are accepted mainly on a basis of physical tests made at the makers' works. Other steels (*e.g.*, rails and axles) are covered by both physical and chemical tests. Cast iron is generally accepted on physical tests alone, though as complex cast-iron alloys are becoming more common to obtain certain specific properties (heat resistance, strength, as in motor-vehicle crankshafts, etc.), the chemical composition is also specified in some cases.

Non-ferrous alloys may be specified to meet certain chemical and/or physical conditions, according to the use to which the material is to be put, and alloys generally are required to be of compositions which are indicated with clearly-defined limits.

Sometimes it happens that the chemical compositions required and the physical properties demanded are not related to one another, attainment of the one meaning that it is impossible to satisfy the requirements in the other direction. When this is the case, obviously the only thing to do is to find out which is the more important and to meet that, at the same time drawing the attention of the issuing authority to the inconsistency.

Detail Required

Precisely how much detail to give is a point which often causes some anxiety when preparing a specification. Insufficient detail may result in unsatisfactory material being bought, whilst excessive detail may mean unduly high prices being paid, apart from possible ambiguities in expression causing more worry. As little detail should be given as will suffice to secure what is wanted, but so much *must* be given. This may be considered under seven heads;—(*a*) Raw material; (*b*) process of manufacture; (*c*) physical properties; (*d*) chemical properties; (*e*) performance tests; (*f*) methods of testing, including preparation of test-pieces; and (*g*) marking and packing.

It is rarely necessary to enter into any detail about the raw materials, as usually the manufacturer will know by an inspection of the physical and/or chemical requirements what raw materials he can use.

Process Specification

To specify the process of manufacture is not necessarily wise. Where certain properties can best be obtained by the use of certain recognised processes and the use of others leads to unsatisfactory results, it is perhaps worth while at times to indicate which processes must be used. On the whole, however, it is better to leave such matters to the discretion of the manufacturer, who may be relied upon to use the methods which will give him the best product, even though they may not be the cheapest. This enables him also to make the fullest possible use of improvements in manufacturing methods which are introduced from time to time, practically always to the advantage of the purchaser of the product.

Physical properties are usually important where metals are concerned, and also for some other materials such as cement, oils, etc. The properties specified must be those which really matter. This sounds, and indeed is, obvious, but frequently inexperienced people drafting specifications include properties which are entirely unimportant.

It is upon the chemical constitution clauses that many specifications break down, generally owing to a lack of appreciation of the importance of individual constituents. In some alloys, for example, traces of metals make a great deal of difference. In tin-base white-metals a mere trace of zinc ruins the structure, and small quantities of lead affect the properties appreciably, whereas larger amounts have quite a different effect. The presence of a trace of phosphorus in bronze is usually evidence of the use of phosphor copper in making it, just as a trace of aluminium in steel indicates a clean, deoxidised steel. Considerable discretion must be exercised, however, in setting limits to what appear to be minor constituents, and working tolerances must always be allowed on the major ingredients.

Performance Tests

Performance tests are always difficult to specify, as conditions of use vary so greatly. Two lots of the same material, bought for the same purpose, may prove satisfactory in one case and unsatisfactory in another because of some minor variation in conditions of use. Inasmuch as it is impossible to provide for every possible contingency, it is best to limit the references to performance tests as much as possible. If the materials meet the other conditions of the specification (which have been laid down with respect to normal use) as a rule they will be quite satisfactory.

Methods of testing should always be defined closely, and whenever possible by reference to some standard method recognised as giving consistent results in any competent observer's hands, *i.e.*, uninfluenced substantially by personal factors. This will involve sometimes a definition of the method to be followed when making or preparing test-pieces, upon which there is not always agreement. In such circumstances the only line to adopt is to take the method which is known, or is felt, to be likely to give the most useful results. For instance, for some purposes a separately-cast test-bar will be more suitable than one cast integrally with the main casting, and subsequently cut off. The point is one for each user to decide for himself, as quite different results may be obtained according to the method chosen for preparing the test-bar.

Sizing and Packing Specifications

A final section of the specification usually deals with sizing, packing and marking. Here preferences differ, both among users and among manufacturers. Metal bars are generally available in lengths within a certain range. It may be of some importance to have them all the same length, but usually it is not, and to ask for them to be cut to a standard length may add 10 per cent. or more to the price. Manufacturers always have certain everyday packings, and it pays to accept them if possible. To ask for a special size of container, or a special form of packing, means often that the supplier has to buy specially, or to alter his routine of production. This costs money and is always charged against the purchaser.

Preparation of specifications is not a job for one man only, but should be divided among two or three responsible persons. The designer in the drawing office, or the works manager, says what properties he wants; the metallurgist or chemist indicates how these properties can be obtained, and finally the supplier should be invited to collaborate. Frequently this third collaborator is not brought in until after the specification has been issued, which is a grave mistake. Suppliers and users have similar interests, and often supplies can suggest minor changes which make it possible for them to supply

* Chief chemist, Egyptian State Railways, Cairo.

standard material from stock instead of making specially, and this is always advantageous from the point of view of cost. Such changes need not affect the utility of the material, but they often make it much cheaper, and may widen the field of supply and so reduce costs still further by introducing a competitive element into the buying.

Unambiguity

The *sine qua non* of a specification is clarity of expression and definiteness. Such expressions as "perfectly smooth," "substantially free," "fine grain," and "about" should not be used, as they can be interpreted in various ways. Where figures can be given, they should be quoted, and if a range is permissible, maxima and minima should be stated. A specification is not a legal document, though it may form an integral part of one, and it should be couched in language as simple and straightforward as possible. It is related of the late Mr. Pierpoint Morgan that he retained the services of a professor of English, for whom he searched for years, purely and simply to write telegrams and cablegrams for him, because of the professor's ability to use words which meant only one thing. Specifications should be written in the same way, not necessarily with telegraphic brevity, but with outstanding clarity, so that the meaning is obvious and alternative meanings cannot exist.

Specifications should not be regarded as unalterable. Frequent changes of a minor character may be a nuisance, but from time to time all specifications should be reviewed and revised if necessary. New manufacturing processes may present vastly improved materials for which the specifications extant are manifestly inadequate, and the opening up of new sources of supply may make an alteration of chemical requirements desirable. There are very few specifications to-day which will persist in precisely the same form five years hence.

Every endeavour should be made to avoid the development of a "specification complex," or that attitude of mind in which all proprietary brands of material are anathema, and a specification is insisted upon for everything. Such a state of mind leads to great difficulties, for there are still some things of which our knowledge is not yet sufficient to enable us to specify them properly. Varnish, for example, cannot be specified adequately as yet, and the attempts which have been made in that direction so far have been almost a complete failure. Varnish can be purchased only on performance. There are other materials in the same category, though happily they are not numerous. So far as possible existing standard specifications should be adopted, as they represent products which are in normal (and therefore economical) production. Specifications which are not standard, and which involve unusual care in manufacture, merely lead to high prices, and often do not secure material which is any better than the standard quality.

Specifications help three classes of people, viz.: the buyer (purchasing agent for the works or firm), the user (the designer), and the manufacturer (the original supplier). The advantages to each class have been indicated above, but there is a wider value which should be mentioned, and that is the impetus given to research and development in manufacturing processes. Makers whose plants are not laid out to meet generally accepted specifications are bound to bring them into line. The demand for certain products for which close limits are laid down stimulates the improvement of plant and the design of new, and the close competition aroused leads to pure research with the idea of producing still better materials.

INTERNATIONAL COMBUSTION, LIMITED, have received orders for four boilers for the Indian Iron & Steel Company, Limited. The order includes air heaters, draft plant, and boiler-house piping and coal- and ash-handling plant.

Ladle Safety Covers

In many foundries, bull ladles used for the carrying of liquid iron experience considerable shocks when passing over rail or turntable joints, which often result in spills. Mr. Rieder, of the Rosières Works Safety Committee, has designed a cover which effectually prevents accidents. This method is now giving entire satisfaction. As will be seen by Figs. 1 and 2, it consists of a cover closing the ladle and stopping any spillage, but in addition the cover must be (1) able to resist the heat radiations from the contents of the ladle; (2) able to be put at one side and stay in this position for relining or receiving metal from the cupola; (3) so designed as not to interfere with the teeming of the iron into hand shanks, and (4) robust and be free from any complicated mechanism. Figs. 1 and 2 show clearly how this is attained. The lid A (Fig. 1) is a 4-mm. thick spherical segment. It is bolted to the two strip-iron arms B and B', of which each one carries halfway up an inverted hook engaging with a short shaft attached to the trunnions of the ladle body. At the base of the strip-iron arms are cast-iron counterweights C, C'. These counterweights normally maintain the lid in the horizontal position, but by pushing the lever D to either the right or the left the cover can be turned away, and the two ratchet devices E and E' allow the locking of the cover in the tilted position and to give free access to the ladle opening when the lid is in the vertical position. Two ratchets are essential, as this allows, no matter which side of the ladle faces the cupola spout, the lid being turned down to that side so that even if the ratchet is defective the spout itself prevents the flying back of the lid.

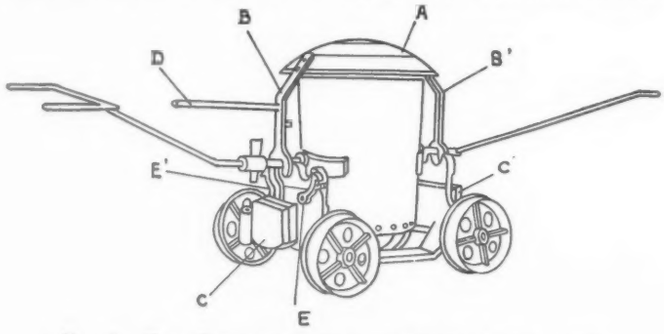


FIG. 1.—BULL LADLE EQUIPPED WITH SPECIAL SAFETY COVER.

FIG. 2.—TEEMING METAL INTO HAND SHANK FROM BULL LADLE EQUIPPED WITH SAFETY COVER.

Segregation Phenomena in Lead Bronzes

(*Concluded from page* 343.)

per cent. of nickel. A transverse section of such a tube is illustrated in Fig. 5; the different layers are indicated, and their compositions given in the adjoining table. It has been proved by X-ray examination that this phenomenon is caused by the elimination of gas from the interior of the casting; hence marked porosity was found in the interior of the transverse section in question.

Inverse segregation in the ingot is caused and influenced by the rapidity of solidification of the metal; this is shown schematically in Fig. 6, and it will be observed *inter alia* that in general a high freezing velocity favours the avoidance of such segregation. In the case of the casting already referred to, which was made in a dry-sand mould, it has, in fact, been noted that rapid cooling practically entirely prevents inverse segregation; the procedure followed was to knock out the casting about ten minutes after pouring and to cool rapidly in water.

In this Paper two possible types of segregation phenomena in lead bronzes have been referred to. It has been shown, in the first place, that a layer-formation may arise which is the natural consequence of the low alloying capacity of the metals concerned, but that this type is not at present of great technical importance, as alloys of the compositions which tend to show it do not find much practical application. Secondly, inverse segregation is a considerably more dangerous phenomenon; this was examined in the case of a copper-lead-tin-nickel alloy. The methods of combating inverse segregation have been discussed.

CLEAN IRON
SAVES COKE IN THE CUPOLA

The cleaner iron given by Workington Machine Cast Pig (free from sand fused to the surface) saves fuel in the cupola. A foundry which used Machine Cast Pig reports the following results:

- Coke consumption decreased by 20%
- Slag from the cupola reduced by 45%
- Limestone charged reduced by 50%
- Quantity of iron melted increased by 24%
- Hanging eliminated completely.
- Castings cleaner.
- Metal composition more regular.
- Longer Life of Cupola Lining.

THE UNITED STEEL COMPANIES LTD

Write to The Publicity Department, The United Steel Companies Ltd., 17, Westbourne Road, Sheffield, 10, for Brochure "Machine Cast Pig Iron."

WORKINGTON
MACHINE · CAST · PIG · IRONS

WORKINGTON IRON & STEEL COMPANY · WORKINGTON · CUMBERLAND

BRANCH OF THE UNITED STEEL COMPANIES LIMITED

W.33

The Week's News in Brief

Trade Talk

A FIRE OCCURRED at the works of the Ince Waggon & Iron Works Company, Limited, Ince, near Wigan, last Thursday. It was extinguished within an hour and a half.

THE FURNESS SHIPBUILDING COMPANY, LIMITED, Haverton Hill-on-Tees, have received an order for a floating dock of 4,000 tons capacity, for the South African Harbours and Railways Administration.

RUNBAKEN ELECTRICAL PRODUCTS inform us that they have removed their sales and repair service department from 280, Deansgate to more commodious premises at 13-15, Liverpool Road, Deansgate, Manchester.

CARRON COMPANY are to extend their engineering works department at Bainsford, Falkirk, at a total cost of £5,000. Plans were passed at Falkirk Dean of Guild Court last week for the erection of a new machining shop and loading bench with a shop office.

THE STAVELEY COAL & IRON COMPANY, LIMITED, near Chesterfield, have opened a stock yard for the London area, the address being Southern Railway Kew Bridge Goods Depôt, Great West Road, Brentford. The firm is now carrying at this depôt a stock of sand-spun, metal-spun and vertically-cast pipes, and a large variety of special castings, from which immediate delivery can be given.

H.R.H THE DUKE OF KENT opened last week the Treforest Trading Estate, South Wales, in connection with which contracts to the value of £400,000 have already been let. A great contribution towards relieving unemployment in South Wales has been made by this enterprise. Facilities are being provided for both large and small manufacturers, and already tenants representing a great diversity of industry have taken sites.

A JOINT MEETING between the Staffordshire Iron and Steel Institute and members of the Iron and Steel Institute resident in the Birmingham district is to be held in the Dudley and Staffordshire Technical Institute, Broadway, Dudley, on Tuesday, November 9, at 7 p.m., when a Paper by Mr. J. E. Hurst on "Some Experiments on the Influence of Silicon, Phosphorus and Manganese on Nitrogen-Hardening Cast Iron," will be presented and discussed. Mr. T. G. Bamford, President of the Staffordshire Iron and Steel Institute, will take the chair.

THE INTERNATIONAL MEEHANITE METAL COMPANY, LIMITED, has removed to more central premises at 66, Victoria Street, London, S.W.1. Mr. E. H. Jones has resigned his position and has severed his connection with the company, and Mr. O. Smalley (H.M. Consul in Pittsburgh, U.S.A.) has now become general manager and director of the British company. Mr. N. E. Rambush and Mr. J. Cameron, J.P., are remaining as directors, and Mr. E. M. Currie has been appointed European service manager. Consequent upon the rapid growth of the organisation, the technical staff has now been augmented by the addition of Mr. H. H. Ashdown, who was formerly with Sir W. G. Armstrong-Whitworth & Company, Limited, and more recently with the Westinghouse Electric Manufacturing Company of America.

THE NEW COMPANY which has been formed under the name of Ferguson-Brown, Limited, for the purpose of amalgamating the interests of Harry Ferguson, Limited, and David Brown Tractors, Limited, both of Huddersfield, will combine the sales and manufacturing activities formerly carried on by the two separate companies. The two companies, Harry Ferguson, Limited, and David Brown Tractors, Limited, were put into voluntary liquidation last month, and the assets and liabilities were taken over by Ferguson-Brown, Limited, as from that date. The capital of the new company is £100,000, divided into 25,000 6 per cent. redeemable preference shares of £1 each, 15,000 "A" ordinary shares of £1 each and 60,000 "B" ordinary shares of £1 each, all the shares being fully paid. Mr. F. E. Brown is chairman of the board of directors and Mr. David Brown and Mr. Henry G. Ferguson are the joint managing directors. Mr. Ernest de Silly Hamilton Browne, Mr. Thomas MacGregor Greer, and Mr. Arthur Sykes are also members of the board.

AT A MEETING of the Grand Council of the Federation of British Industries, Mr. A. P. M. Fleming, who represents the Federation on the Advisory Council of the South Kensington Science Museum, appealed for the support of the Federation for certain recommendations which the Advisory Council were making to the Government. In 1910, the Government appointed a Committee to consider the erection of a museum dealing with scientific discovery and the application of science to industry. This Committee recommended that buildings consisting of three blocks should be built, the first to be started forthwith (1912), and the others to follow on as soon as the first block was ready for occupation. Unfortunately, the block which at present houses the Science Museum was not completed until 1928, and the other blocks have not been commenced. As a consequence, not only is there extremely acute congestion in the present block, but there are many articles in store which should rightly be exhibited. There are also many additions still to be acquired, and additional space is also required for holding special temporary exhibitions. Moreover, modern research promises a continued increase in the number of subjects and aspects of industrial progress calling for presentation. The Advisory Committee, considering that the full space provisions recommended by the 1910 Committee would never be adequate to meet immediate or future needs, propose to recommend that the whole of the site bounded by the eastern wall of the existing museum, and by Exhibition Road, Imperial Institute Road and Queen's Gate be finally allocated to the Science Museum. The Federation approved of the case made out for increased space for the Science Museum, and a letter has been sent to the President of the Board of Education strongly supporting the recommendations of the Advisory Council.

Personal

MR. C. H. KAIN has changed his home address to 24, The Street, Stisted, near Braintree, Essex.

MR. ALAN FINDLAY, general secretary of the United Patternmakers' Association, has been re-elected for a period of three years.

DR. A. W. ASHTON, who recently retired from the position of head of the Engineering Department of the North Staffordshire Technical College, received a presentation at a meeting of the Stoke-on-Trent Association of Engineers, on October 13.

MR. FREDERICK COLIN FRANKS, who recently retired after 58 years' service with C. & W. Walker, Limited, gas plant manufacturers and engineers, of Donnington, Wellington, Shropshire, received a presentation recently from the directors of the company. Mr. Franks served 28 years as manager.

Contracts Open

Cheadle, November 1.—Providing and laying 790 yds. 4-in. cast-iron mains and 633 yds. 2-in. cast-iron mains, for the Rural District Council. The Surveyor, Council Offices, Cheadle, Stoke-on-Trent.

Cononley, November 4.—Providing and laying 400 yds. 4-in. and 300 yds. 3-in. spun-iron pipes, for the Skipton Rural District Council. Mr. A. Rodwell, surveyor, Rural District Council Offices, Granville Street, Skipton. (Fee £2 2s., returnable.)

Manchester, November 4.—Gunmetal and phosphor-bronze castings; malleable iron castings; bolts and nuts, for the Cleansing Committee. Mr. B. B. Jones, director of public cleansing, Town Hall, Manchester.

Auckland, December 7.—Two 110-ton turntables, for the Auckland Harbour Board, New Zealand. Mr. C. R. Butters, c/o H. H. Lloyd & Company, 41, Cheapside, London, E.C.2.

Camborne, November 4.—Electrically-driven crushing plant, for the Camborne-Redruth Urban District Council. The Surveyor, Station Hill, Redruth.

Southend, November 22.—Supply and erection of high-class pumping plant. J. D. & D. M. Watson, civil engineers, 3, Central Buildings, Westminster, S.W.1. (Fee £3 3s., returnable.)

THE L.N.E.R. HAS PLACED CONTRACTS with Cowans, Sheldon & Company, Limited, Carlisle, for three 70-ft. turntables to be installed at Marylebone, Leicester and Darlington locomotive depôts.

Catalogue Received

"Sand" Blasting. The receipt of a catalogue running to over two hundred pages from R. J. Richardson & Sons, Limited, of Commercial Street, Birmingham, 1, serves to remind us that congratulations are due to the firm on the attainment of their golden jubilee. Eight years after the establishment of the firm, an agreement was entered into with Tilghman's Patent Sand Blast Company, Limited, to represent them in the Midlands, and this contract is still in force! This, too, must be something of a record. Other agencies held are David Bridge & Company, Limited, Castleton, Manchester; George Green & Company, Keighley; D. Mitchell & Company, Limited, Keighley; and John Macdonald & Son, Glasgow. Another major activity of this firm is sand or shot blasting to the trade.

Most of the catalogue is designed to interest foundry executives, and whilst covering most normal plant, several of the more uncommon types of foundry machines are described, such as pig breakers and baby Bessemers. There is a wealth of useful technical data, which have been well chosen and presented in the form of tables. We have only one adverse comment to make on this well-prepared, business-like brochure, and that is the use of the word "grinding" in connection with sand mills. For lay-out and general presentation, the section dealing with the airless "Wheelabrator" represents the highest type of trade literature.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Patent Axle Box & Foundry Company (1937), Limited.—Capital, £100. Director: T. G. Bird. 6, Manor Road, Tynemouth.

H. Goodwin, Limited.—Capital, £5,000 in £1 shares. Malleable and grey iron founders, etc. Directors: H. Goodwin, 161, Bentley Lane, Walsall; R. H. Goodwin, and G. R. Morgan.

British Adamite Alloy Roll Company, Limited, Netherton Iron Works, Holly Hall, Dudley.—Capital, £5,000. Directors: J. Tennent, O. F. Grazebrook, W. H. Lewis, H. E. Cookson, and R. B. Tennent.

Forthcoming Events

NOVEMBER 4.

Institute of Metals (Birmingham Section):—"Die-casting," Paper by A. C. Street, Ph.D., B.Sc., at the James Watt Memorial Institute, Birmingham, at 7 p.m.

Institute of British Foundrymen

OCTOBER 30.

Falkirk Section:—"Question Night," at Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

NOVEMBER 1.

Lincolnshire Section:—"Recent Developments in Foundry Machinery," Paper by V. C. Faulkner, at the Lincoln Technical College, at 6.45 p.m.

NOVEMBER 3.

London Branch:—"Trends in Continental Steelfoundry Practice," Paper by P. Fassotte, at Charing Cross Hotel, London, W.C.2, at 8 p.m.

NOVEMBER 5.

Birmingham, Coventry and West Midlands Branch:—Joint meeting with Midland Section of The Institute of Vitreous Enamellers. Report of Costing Sub-Committee, "Recommendations concerning the Establishment of Costs in a Grey Iron Foundry," presented by V. Delport, at James Watt Memorial Institute, Great Charles Street, Birmingham, at 7.30 p.m.

NOVEMBER 6.

Lancashire Branch:—"Cupola Practice in a Textile Engineering Works," Paper by J. Jackson, at Engineers' Club, Albert Square, Manchester, at 4 p.m.

Wales and Monmouth Branch:—"Moulding Castings for a Vertical Pump Motor," Paper by T. W. Trayherne, at University College, Cardiff, at 6.30 p.m.

The Institute of Vitreous Enamellers

NOVEMBER 4.

Northern Section:—"Analyses of Cast Iron suitable for Vitreous Enamelling," Paper by H. Cowan, B.Sc., at Queen's Hotel, Manchester, at 7.30 p.m.

TOR ROCK SAND
for the
FOUNDRY

Higher casting temperatures in iron foundries—particularly in those where special alloys are melted—have resulted in a demand for a moulding sand to withstand severe conditions and produce sound castings of good finish. Tor Rock Sand has proved to be specially suitable for these requirements. It is coarse in grain and highly permeable and being somewhat irregularly graded, tends to give a strong and compact mould surface.

Please write for full particulars and sample to the nearest sales office:

GENERAL REFRACTORIES LIMITED
GENEFAX HOUSE, SHEFFIELD.

Telephone: 31113 (6 lines).

Telegrams: "Genefax, Sheffield."

LONDON OFFICE:	SCOTTISH OFFICE:	SWANSEA OFFICE:	MANCHESTER OFFICE:	MIDDLESBROUGH OFFICE:	CARDIFF OFFICE:
Russell House, Adelphi, W.C.2.	48, West Regent Street, Glasgow, C.2.	Metropole Chambers, Wind Street.	9, Albert Square.	Halifax Bldgs, Exchange Place.	17, Windsor Place.
Telephone: Temple Bar 3511.	Telephone: Douglas 6108 (3 lines).	Telephone: 3680.	Telephone: Blackfriars 6130.	Telephone: Middlesbrough 3313.	Telephone: 5796.
Telegrams: "Genefax, Rand-London." (Mr. A. C. Turner).	Telegrams: "Genefax, Glasgow." (Mr. C. A. G. Thomson).	Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).	Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).	Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).	Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

Activity at the iron and steel consuming works is fully maintained and order-books indicate that these conditions will continue well into next year. Delivery arrears of substantial proportions still remain to be overcome.

Pig-Iron

MIDDLESBROUGH.—Consumers can obtain small supplementary tonnages of Cleveland iron in some cases, but generally little new business can be negotiated, producers being considerably in arrears with contracts. Prices are nominal at 101s. delivered Middlesbrough for No. 3 G.M.B., 104s. in Falkirk and 107s. on Clydeside. Shipments to Scotland are few and far between and the first cargo of the month to that area left the Tees for Grangemouth recently. After home requirements have been met there is very little hematite available for export. There is an active request for special irons. For deliveries up to the end of December, the current quotations for East Coast mixed numbers are 122s. 6d. in the North-East Coast district, 128s. in Sheffield and 133s. 6d. in the Midlands.

LANCASHIRE.—Pig-iron makers are not anxious to arrange business for 1938 deliveries and will only negotiate on condition that the price operative at the time of despatch is paid, thus covering themselves against higher quotations, which are almost certain to prevail in the New Year. Consumers continue to be very well employed. For delivery to users in the Lancashire price zone, offers of Derbyshire and Staffordshire brands of No. 3 foundry iron are on the basis of 109s., with Northamptonshire at 107s. 6d. and Derbyshire forge iron at from 104s. to 106s., according to the class of user. Local users of pig-iron have not displayed much interest in foreign material recently; American iron is now quoted at 142s. 6d. for delivery in Lancashire, with Continental iron at 120s. The hematite market is easier, but prices remain unchanged.

MIDLANDS.—Consumers of ordinary grades of foundry iron have every reason to be well satisfied with the tonnage which they are receiving from the furnaces, for they are now able to build up stocks, although, as yet, these are of meagre extent. For delivery to Birmingham and Black Country stations, Northants No. 3 is quoted at 103s. 6d., with Derbyshire, Lincolnshire and North Staffordshire No. 3 at 106s. Any 1938 business is done at prices ruling at the time of delivery. Supplies of forge pig-iron are better; the price is 5s. per ton below the foundry iron quotations. Most consumers of special irons have expanding requirements, and there is little surplus material after contracts have been met. Defence work is responsible for the consumption of a large tonnage of the better-class irons. New business in hematite is scarce, as makers generally are fully sold up to the end of the year. For deliveries up to December 31 in the Midland area, East Coast No. 3 is quoted at £6 13s. 6d., with West Coast mixed numbers at £6 14s. 6d. Ordinary foundry descriptions of hematite are now easier to procure.

SCOTLAND.—Light-castings founders remain comparatively quiet, but activity among the heavy engineers is maintained. The distribution of pig-iron is still restricted, but most users are well catered for, although it is not generally possible to accumulate stocks. No. 3 foundry iron is quoted at 118s. f.o.t. furnaces, with No. 1 at 120s. 6d. Producers are obtaining more than these figures for new business, small as it is. No. 3 Cleveland is quoted at 104s. f.o.t. Falkirk and 107s. f.o.t. Glasgow. Activity at the steelworks is fully maintained, and order-books are filled to capacity. Prices of steel-making irons are unaltered at 123s. for mixed numbers of hematite, 107s. 6d. for Scottish basic, and 100s. for Indian and English basic, all less 5s. rebate, delivered steelworks in this area.

Coke

Although Durham collieries are willing to enter into contracts for deliveries over the whole of 1938, consumers generally desire to cover only their winter requirements. For delivery to Birmingham and district, best Durham foundry coke is quoted at 55s. 9d., with Welsh coke at from 55s. to 65s. per ton.

Steel

Although in some departments of the steel market supplies are easier than for many months, the general situation remains tight, and the pressure from consumers to obtain deliveries is unrelaxed. Little new business is being transacted at the moment, since the producers are concentrating upon reducing their overcrowded order-books, and most consumers are waiting until information is available regarding the prices which will rule next year. The quiet period may be expected to continue for a time, but this will afford relief rather than otherwise to the steelmakers, who are provided with sufficient work to keep them busily occupied over the first quarter of 1938, and in some cases beyond. The demand for semi-finished steel shows no signs of shrinking, and the stringency in this department is probably more severe than in any other. The heavy production of the British works, however, combined with larger supplies from abroad, promises an improvement in the near future. Business in finished steel has been quiet, but substantial deliveries are being made to the consuming industries. The export demand remains dull, but a good tonnage is still due against contracts.

Scrap

The call for supplies of iron and steel scrap remains heavy and merchants are employing every method in their endeavour to increase the available tonnage. There appears to have been a further improvement in the supply of cast-iron scrap, but there is still difficulty in obtaining adequate tonnages in some areas, particularly the Cleveland district. Contracts in most cases account for the full production of all descriptions and any surplus is soon bought at current prices.

Metals

Copper.—Consumption of copper continues to be on an excellent scale, but consumers are not anxious to take up further large supplies while the market remains so uncertain. In the United States, selling prices have been stabilised at 12 cents per lb., delivered Connecticut Valley. Business has been quiet.

Profits of Mufulira Copper Mines, in which Rhodesian Selection Trust has a large interest, have risen by £536,692, to £839,050. Production rose from 28,123 to 37,230 tons of blister copper in the year ended September last. An initial dividend of 15 per cent. is to be distributed. After wiping out the debit of £93,545 brought in, a credit balance of £133,205 is carried forward. Referring to operations at the mine, the report states that good progress has been made with the construction of the additional crushing plant. Work is in progress for increasing mine development, concentrator, power plant and smelting capacity, and it is anticipated that by October, 1938, the mine and plant will be in a position to produce 8,000 tons per month.

The report of the Rhokana Corporation, Limited, for the year to June 30 last states that the profit from operating account increased by £1,340,167 to £2,166,911. Total profit showed an increase of £1,343,836 at £2,175,057, while net profit was £2,019,866, compared with £600,295 in the previous year. The report mentions that there has been considerable expansion in the scale of operations; 2,651,200 short tons of ore was treated in the concentrator. Production of fine copper was 46,247 tons in the form of electrolytic copper, a total of 75,254 tons, as compared with 50,399 tons. Sales of cobalt during the year have shown a considerable increase.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £44 18s. 9d. to £45; Friday, £45 to £45 2s. 6d.; Monday, £42 7s. 6d. to £42 10s.; Tuesday, £43 6s. 3d. to £43 8s. 9d.; Wednesday, £42 8s. 9d. to £42 11s. 3d.

Three Months.—Thursday, £45 3s. 9d. to £45 5s.; Friday, £45 6s. 3d. to £45 7s. 6d.; Monday, £42 15s. to £42 16s. 3d.; Tuesday, £43 13s. 9d. to £43 15s.; Wednesday, £42 16s. 3d. to £42 17s. 6d.

Tin.—An official *communiqué* issued after a special meeting in London on Monday of the International Tin Committee, stated that on a review of all the relevant information at present available, the Committee came to the conclusion that the quota for the January-March quarter of 1938 should be 85 per cent. of the standard tonnages; but that a definite decision as to the quota would not be taken till the meeting on December 10, when further information would be before them. They considered it advisable, however, to publish the information above as to their views, based on the data now available. The reduction to 85 per cent. would mean a fall of 25 points as compared with the present level. The market has again been uncertain, and prices have varied from day to day.

According to statistics published in the October issue of the International Tin Research and Development Council's Bulletin, issued by The Hague Statistical Office, world tin production in the twelve months ended August, 1937, amounted to 192,868 tons, against 169,796 tons in the preceding twelve months. World tin production in September amounted to over 19,000 tons, against 17,200 tons in August, and 14,500 tons in September, 1936. World apparent tin consumption in August was 14,635 tons, against 13,187 tons in the preceding month and 13,271 tons in August, 1936. Consumption in the year ended August, 1937, at 175,580 tons was 95.50 per cent. of 1929 consumption. Tinplate production amounted to 4,113,000 tons in the year ended August, 1937 (preceding year 3,373,000 tons), and the quantity of tin used in this industry amounted to 67,900 tons (preceding year 56,200 tons). During September visible stocks decreased by 3,132 tons to 22,032 tons, representing 12.5 per cent. of the current annual rate of consumption.

Official quotations were as follow :—

Cash.—Thursday, £222 10s. to £223; Friday, £218 15s. to £219; Monday, £204 10s. to £205; Tuesday, £208 10s. to £208 15s.; Wednesday, £206 to £206 10s.

Three Months.—Thursday, £222 to £222 10s.; Friday, £218 10s. to £219; Monday, £204 10s. to £204 15s.; Tuesday, £208 10s. to £208 15s.; Wednesday, £206 to £206 5s.

Spelter.—This market continues to fluctuate in sympathy with the trend of international events, and the outlook remains uncertain. The American market has continued quiet, and the price has declined to 6 cents per lb. East St. Louis.

Daily market prices :—

Ordinary.—Thursday, £17 6s. 3d.; Friday, £17 10s.; Monday, £16 6s. 3d.; Tuesday, £17 1s. 3d.; Wednesday, £16 16s. 3d.

Lead.—While little headway can be made under existing conditions, the undertone of this market remains firm. Buying on trade account has been quite satisfactory. The domestic quotation in the United States has been reduced to 5.50 cents per lb. New York, and business has been quiet.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £18 5s.; Friday, £18 11s. 3d.; Monday, £17 8s. 9d.; Tuesday, £18 1s. 3d.; Wednesday, £17 16s. 3d.

Scrap.—Another week of dull trading has been experienced on the non-ferrous scrap metal market, and prices have further depreciated. Consumers continue to show little, or no, interest in their forward requirements.

Approximate selling prices for old metal:—New aluminium cuttings, £82; rolled, £67; cast, £40; foil, £94 to £98. Copper, £39 to £43; braziery, £37. Brass (clean), £27 to £32. Zinc, £11. Lead, £17. Gunmetal, £41 to £42.

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.
We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.
Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.

Make your own core oils and cut your binder costs with KORDEK

■ Leading foundries find that by using "Kordek," the new all-purpose sand binder, they can cut costs by as much as 50%. "Kordek" is a dry binder which makes core production more economical and gives the foundryman complete control over his core sand.

You simply feed "Kordek" to your mill along with your sand and a small quantity of oil and water. Thus you obtain any degree of bond, green or dry, at the lowest possible cost.

TEST KORDEK IN YOUR FOUNDRY AT OUR EXPENSE. A trial will cost you nothing and will prove how "Kordek" can cut binder costs in *your* foundry. Mixings and a working sample will be supplied free of charge. One of our technicians is also available for demonstration and advice.

KORDEK

THE ALL-PURPOSE BINDER FOR CORES AND FACINGS

Manufactured by
CORN PRODUCTS COMPANY LTD., Bush House, Aldwych, London, W.C.2.
BRANCHES: MANCHESTER: BIRMINGHAM: LEEDS: BRISTOL: NEWCASTLE: GLASGOW FACTORY: MANCHESTER

WARNER Special PIG IRONS

- Warner C.B.R. and Low Carbon Cylinder (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

● **Typical Cylinder Pig Iron Specification**

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

● **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO. LTD.
CARGO FLEET MIDDLESBROUGH

RAW MATERIALS—PRICE LIST

(Wednesday, October 27, 1937)

COPPER

	£	s.	d.
Standard cash	42	8	9
Three months	42	16	3
Electrolytic	47	10	0
Tough	47	7	6
Best selected	47	17	6
Sheets	79	2	6
India	58	15	0
Wire bars	49	2	6
Ingot bars	49	2	6
H.C. Wire rods	52	12	6
Off. av. cash, Sept.	53	0	7 3/44
Do., 3 mths., Sept.	53	2	2 1/4
Do., Sttlmnt., Sept.	53	1	0 3/11
Do., Electro, Sept.	59	12	7 4/11
Do., B.S., Sept.	60	0	7 1/2
Do., wire bars, Sept.	60	5	10 1/11
Solid drawn tubes			13d.
Brazed tubes			13d.
Wire			8 1/4d.

BRASS

Solid drawn tubes	11 1/4d.
Brazed tubes	13 1/2d.
Rods, drawn	9 3/4d.
Rods, extd. or rlld.	7d.
Sheets to 10 w.g.	9 1/4d.
Wire	8 1/4d.
Rolled metal	8 3/8d.
Yellow metal rods	7d.

TIN

	£	s.	d.
Standard cash	206	0	0
Three months	206	0	0
English	206	0	0
Bars	208	0	0
Straits	209	10	0
Eastern	214	17	6
Banca (nom.)			—
Off. av. cash, Sept.	259	2	2 13/22
Do., 3 mths., Sept.	258	1	9 5/22
Do., Sttlmt., Sept.	259	1	8 5/11

SPELTER

	£	s.	d.
Ordinary	16	16	3
Remelted	15	0	0
Hard	14	0	0
Electro, 99.9	20	10	0
English	18	2	6
India	15	10	0
Zinc dust	24	0	0
Zinc ashes	6	5	0
Off. aver., Sept.	21	10	1 47/88
Aver., spot, Sept.	21	8	1 1/2

LEAD

	£	s.	d.
Soft foreign, ppt.	17	16	3
Empire (nom.)	18	17	6
English	19	15	0
Off. aver., Sept.	21	0	4 1/11
Aver. spot, Sept.	20	19	9 27/44

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	30	10	0 to	31	0	0
Do., V.M. ex-whse.	30	10	0 to	31	0	0
Rods				26	0	0

ANTIMONY

English	92	10	0 to	93	10	0
Chinese, ex-whse. (nom.)				81	0	0
Crude, c.i.f.				47	0	0

QUICKSILVER

Quicksilver	13	3	4 1/2

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	14 10 0
45/50%	12 0 0
75%	17 0 0
Ferro-vanadium	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	9/3 lb.
Tungsten metal powder—	
98/99%	9/6 lb.
Ferro-chrome—	
2/4% car.	34 15 0
4/6% car.	24 5 0
6/8% car.	24 0 0
8/10% car.	24 0 0
Ferro-chrome—	
Max. 2% car.	36 0 0
Max. 1% car.	38 5 0
Max. 0.5% car.	41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 10d.
Finished bars, 18% tungsten	5s. 0d.

Per lb. d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/2 in. to 1/4 in.	3d. lb.
Do., under 1/4 in. to 7/16 in.	1/- lb.
Flats, 1/2 in. × 1/4 in. to under 1 in. × 1/2 in.	3d. lb.
Do., under 1/4 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	6 to	3	11	0
Mixed iron and steel	3	6	0 to	3	8	6
Heavy cast iron	3	8	6 to	3	11	0
Good machinery				3	17	6
Cleveland—						
Heavy steel, best	3	7	0 to	3	9	6
Steel turnings				2	15	0
Heavy cast iron				4	5	0
Heavy machinery				4	10	0
Midlands—						
Short heavy steel	3	17	6 to	4	0	0
Light cast-iron scrap	3	2	6 to	3	5	0
Heavy wrought iron	4	0	0 to	4	5	0
Steel turnings	2	5	6 to	2	8	0
Scotland—						
Heavy steel, best	3	5	0 to	3	7	6
Ordinary cast iron	4	7	6 to	4	10	0
Cast-iron borings	2	0	0 to	2	2	6
Wrot-iron piling				4	17	6
Heavy machinery	4	16	0 to	4	16	3

London—Merchants' buying prices, delivered yard.

Copper (clean)	37	0	0
Brass	25	0	0
Lead (less usual draft)	15	0	0
Tea lead	12	0	0
Zinc	10	0	0
New aluminium cuttings	71	0	0
Braziery copper	33	0	0
Gunmetal	37	0	0
Hollow pewter	140	0	0
Shaped black pewter	100	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	103/6
,, No. 3	101/-
,, No. 4	100/-
Forge No. 4	100/-
Hematite No. 1	123/-*
Hematite M/Nos.	122/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/-*
,, d/d Birm.	134/6*
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	103/-
,, No. 3 fdry.	106/-
Northants forge	100/6
,, fdry. No. 3	103/6
,, fdry. No. 1	106/6
Derbyshire forge	103/-
,, fdry. No. 3	106/-
,, fdry. No. 1	109/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	107/-
,, ,, Falkirk	104/-
Scottish hem. M/Nos. d/d	123/-*
Sheffield (d/d district)—	
Derby forge	100/6
,, fdry. No. 3	103/6
Lincs forge	100/6
,, fdry. No. 3	103/6
W.C. hematite	128/6*
Lancashire (d/d eq. Man.)—	
Derby fdry, No. 3	109/-
Staffs fdry. No. 3	109/-
Northants fdry. No. 3	107/6
Cleveland fdry. No. 3	109/6
Glengarnock, No. 3	140/-
Clyde, No. 3	140/-
Monkland, No. 3	140/-
Summerlee, No. 3	140/-
Eglinton, No. 3	140/-
Gartsherrie, No. 3	140/-
Shotts, No. 3	140/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to	13	15	0
Nut and bolt iron	11	12	6 to	12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, 3/4 in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5/8 in.				12	0	6
Rounds under 3 in. to 3/8 in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				19	10	0
Galv. flat shts. (,,)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	11 1/2d.
Sheet to 10 w.g.	12 1/2d.
Wire	13 5/8d.
Rods	14 1/2d.
Tubes	18 3/4d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3 1/2 to 1/9 1/2
To 15 in. wide	1/3 1/2 to 1/9 1/2
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4 1/2 to 1/10 1/2
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5 1/2
Ingots rolled to spoon size	1/- to 1/8 1/2
Wire round—	
to 10g.	1/6 1/2 to 2/1 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5 1/2 upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	38/6
,, furnace	37/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	24/9 to 25/6
,,	28×20	,,	49/6 to 51/-
,,	20×10	,,	36/6 to 36/9
,,	18 3/4×14	,,	26/3 to 26/6
C.W.	20×14	,,	22/- to 23/-
,,	28×20	,,	45/- to 46/-
,,	20×10	,,	32/- to 32/6
,,	18 3/4×14	,,	23/- to 23/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12	0	0 to	£13	0	0
Bars-hammered, basis	£20	0	0 to	£22	0	0
Bars and nail-rods, rolled, basis	£19	0	0 to	£20	0	0
Blooms	£18	0	0 to	£19	0	0
Keg steel	£30	0	0 to	£35	0	0
Faggot steel	£20	0	0 to	£25	0	0
Bars and rods dead soft st'l	£19	0	0 to	£20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Oct.	21 ..	44 18 9 inc.	31/3
,,	22 ..	45 0 0 ,,	1/3
,,	25 ..	42 7 6 dec.	52/6
,,	26 ..	43 6 3 inc.	18/9
,,	27 ..	42 8 9 dec.	17/6

Electrolytic Copper

		£ s. d.	
Oct.	21 ..	49 0 0 inc.	20/-
,,	22 ..	49 0 0 No	change
,,	25 ..	48 0 0 dec.	20/-
,,	26 ..	49 0 0 inc.	20/-
,,	27 ..	47 10 0 dec.	30/-

Standard Tin (cash)

		£ s. d.	
Oct.	21 ..	222 10 0 inc.	240/-
,,	22 ..	218 15 0 dec.	75/-
,,	25 ..	204 10 0 ,,	285/-
,,	26 ..	208 10 0 inc.	80/-
,,	27 ..	206 0 0 dec.	50/-

Tin (English ingots)

		£ s. d.	
Oct.	21 ..	222 10 0 inc.	240/-
,,	22 ..	218 15 0 dec.	75/-
,,	25 ..	204 10 0 ,,	285/-
,,	26 ..	208 10 0 inc.	80/-
,,	27 ..	206 0 0 dec.	50/-

Spelter (ordinary)

		£ s. d.	
Oct.	21 ..	17 6 3 inc.	12/6
,,	22 ..	17 10 0 ,,	3/9
,,	25 ..	16 6 3 dec.	23/9
,,	26 ..	17 1 3 inc.	15/-
,,	27 ..	16 16 3 dec.	5/-

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
Oct.	21 ..	21 2 6 inc.	15/-
,,	22 ..	21 3 9 ,,	1/3
,,	25 ..	20 10 0 dec.	13/9
,,	26 ..	20 15 0 inc.	5/-
,,	27 ..	20 10 0 dec.	5/-

Lead (soft foreign, prompt)

		£ s. d.	
Oct.	21 ..	18 5 0 inc.	11/3
,,	22 ..	18 11 3 ,,	6/3
,,	25 ..	17 8 9 dec.	22/6
,,	26 ..	18 1 3 inc.	12/6
,,	27 ..	17 16 3 dec.	5/-

Lead (English)

		£ s. d.	
Oct.	21 ..	20 5 0 inc.	10/-
,,	22 ..	20 10 0 ,,	5/-
,,	25 ..	19 10 0 dec.	20/-
,,	26 ..	20 0 0 inc.	10/-
,,	27 ..	19 15 0 dec.	5/-

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	10 5 0	10 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 2 6	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 10½
1934	8 8 1½	8 10 7½	8 16 6	8 17 6	8 6 3	8 6 3	8 6 3	8 5 7½	8 5 0	8 5 0	9 5 0	9 5 0	8 11 0
1935	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0
1936	9 5 0	9 5 0	9 5 0	9 5 0	9 8 1½	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 18 1	9 12 7½	
1937	10 0 6	10 0 6	10 0 6	10 0 6	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LUMPEX

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND

FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

CUPOLAMAN, reliable, desires change. Used to cupolas melting 3 to 8 tons per hr. and 15 to 20 tons per day; also used to balanced-blast and receiver type cupolas.—Box 652, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN or Assistant desires change. Technical knowledge and a sound practical experience in engineering, jobbing, and repetition castings. Ordinary and high-duty cast irons.—Box 610, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Assistant desires position. Ferrous and non-ferrous. General, jobbing, repetition. Practical moulder with technical qualifications. Age 28.—Box 650, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager desires change. Experienced in production of high-class engineering and jobbing work castings; moulding machines, etc. At present in charge of grey-iron and non-ferrous foundry. Guarantee results. I.B.F. man.—Box 638, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

A YOUNG Metallurgical Chemist required to control small chemical and physical laboratory and heat-treatment department; also assist in controlling material in iron foundry of an engineering company in the South of England. Reply giving age, details of experience, and salary required.—Box 628, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager required to take charge of a large iron foundry and small non-ferrous foundry and pattern shop (250 employees) by a company making internal-combustion engines in the South Midlands. The successful candidate must be a first-class practical foundryman with technical experience and a successful record of achievement. State age, full details of experience, and salary expected. Replies will be regarded as confidential.—Reply Box 626, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LEADING Hand required ironfoundry, used to heavy and medium castings, jobbing work. Excellent prospects for good man not over 45 years of age. Full particulars and wages required to: Box 630, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGICAL CHEMIST.—Applications invited for post of Chief Chemist with important firm of Aluminium Founders. Experience in analysis of aluminium alloys essential. Some general metallurgical experience desirable. Apply in confidence, giving full details.—GENERAL MANAGER, WILLIAM MILLS, LTD., Grove Street, Birmingham, 18.

VITREOUS ENAMELLING. — Energetic experienced man required to take complete charge Sheet Iron Section large Stove Works in the South. Frit-making knowledge not required. Knowledge of Cast Iron Enamelling an advantage. Progressive post for right man. State age, experience, and salary required.—Box 654, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SITUATIONS VACANT AND WANTED—*Contd.*

FOUNDRY.—First-class Foreman required for modern mechanised foundry. Must be able to secure maximum output from machines. Apply giving details of past experience, age, and salary required to: Box 644, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

VITREOUS ENAMELLING.—Production Foreman required. Must be accustomed to large quantity output on cast and sheet iron ware. Apply giving details of past experience, age, and salary required to: Box 646, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRYMAN, long experience Diesel engine, steam engine, machine tool and general castings. Mechanised experience, moulding machines, sand slingers, cupolas and metals. Estimating and general control. (309)

MACHINERY

WANTED.—Tropenas Plant, 10/15 cwts. capacity. Must be in good condition.—Box 642, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

GUTTMANN 9-ft. dia. Table Sandblasting Plant, four nozzles. Also several Hand and Pneumatic Moulding Machines. 1½-2-ton Cupola. 10-cwt. and 15-cwt. Cupolettes.—Box 648, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO., LTD., Station Works, Ecclesfield, Sheffield.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

'Phone **98** Staines.

1½- and 2½-ton Morris Overhead Gantry Hand Cranes, 20 and 22 ft. span.
Steel Tank, 12 ft. by 12 ft. by 6 ft.
70 h.p. Robey Crude Oil Engine.
Robey Air Compressor, 850 c.f. at 30 lbs.
HARRY H. GARDAM & CO., LTD., STAINES.

THO[S] W. WARD LTD.

Two "Woodeson" Water-tube BOILERS, each of 5,100 sq. ft. heating surface, 20,000 lbs. evaporation, working pressure 250 lbs.
LANCS. BOILER, 30′ x 9′, 150 lbs. w.p.
LANCS. BOILER, 30′ x 8′ 6″, 150 lbs. w.p.
Large stock flat-ended CIRC. BOILER STORAGE TANKS.
Write for "Albion" Catalogue.
'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

ONE 400-lb. capacity Oil-Firing Tilting Crucible Furnace for melting cast iron. State make, condition and price.—Box 640, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.
EXHAUST FANS (large stock), electrical and belt driven.
ELECTRIC RUNWAY LIFTING BLOCKS:
One 4½-ton 460 volts d.c., Vaughan.
Two 2-ton ditto, Morris.
One ½-ton 220 volts d.c., Morris (as new).
One ½-ton 3/50/440 volts, Aabacas.
Two Reavell Rotary Compressors, 12 lbs. sq. in. pressure; 750 cub. ft. direct-coupled on bedplate to 60 h.p. S.R., 3/50/400 volts motor.
½-cwt. Pilkington Self-contained Pneumatic Hammer.
Geared Foundry Ladles, 9, 4, 3½, 2½ and 1 ton, etc.
AIR COMPRESSORS: 30 in stock in sizes 500 to 20 cub. ft.
ELECTRIC MOTORS: Large stock to suit almost all electric systems.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

MISCELLANEOUS

WAX CORE VENTS in 1-lb. rolls; all sizes from $\frac{1}{16}$ in. dia. Best and cheapest. Quick despatch.—WILLIAM OLSEN, LTD., Hull.

QUEBEC YELLOW PINE.—H. R. Hodgson & Co., Importers, 94, Derby Road, Bootle, Liverpool.

PATTERNS.—Cleghorn & Co. have new premises at 198-200, Bath Road, Worcester, and are in a better position to cope with all classes of engineers' pattern. 'Phone 264.

FLUIDITY TESTS.—Patterns for these tests as described in F.T.J. of September 24, 1936, by Carl F. Joseph. Made in aluminium from our master pattern. 35s. per set. We shall also be glad to have your inquiries for patterns in hard or soft woods for all kinds of engineering, large and small.—FURMSTON & LAWLOR, Pattern Makers, Letchworth.

'Phone: 287 SLOUGH

Large Oil-Sand Mixer, as new Price, £24
New Utard jolt squeeze moulding machine 24″ square ..... Price, £48
3-ton bottom-pouring Steel Ladle, as new ..... Price, £34
Armstrong-Whitworth Rotary Non-ferrous, Oil-fired Furnace, complete with 2 oil-burners, fume hood and all accessories, nearly new, 300-lbs. capacity ..... Price, £50
NEW 36″ × 30″ Sandblast Barrel Cheap

PLEASE SEND FOR OUR LATEST CATALOGUE

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!